POWER

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PHILIP W. SWAIN, *Managing Editor*

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"BIG BERTHA"

• THE INDUSTRY BILL, about to pass the Senate, marks a new industrial revolution. Few even begin to grasp its importance; nobody can know all that it means —not yet. But its aim is clear enough for those who want to see it.

• THIS 16-IN. GUN, loaded and primed, is aimed straight down the industrial alley at unemployment and low wages.

• BUT IT HAPPENS that slow buying and profitless sales—what business men call "poor business"—are in the line of fire. They will be wiped out by the same shots.

• ALMOST AS SURE as this shooting, some business men will get the idea that this is their show, that the administration is merely aiming to "help business" and is ready to train "Big Bertha" on any pea-shooter target that pleases businessmen's fancy. Some may even imagine that they can take their new and better business without passing a fat slice of the profits along to the consumer via wages and salaries.

• THEY WON'T GET AWAY WITH IT; those who won't play the game won't get their sticks of candy.

• BUT THE CANDY IS THERE for all the good boys. The bill to better the condition of the average Tom, Dick and Harry will also (it's the price of the job) bring a living wage to the legitimate manufacturer. It will smother unfair competition. And it will have four results that will test the foresight of every power engineer:

• FIRST: PRICES ARE GOING UP: food, clothing, automobiles—and power machinery. If you doubt this, step across to the office of your own sales manager or purchasing agent. Ask him.

• SECOND: INDUSTRIAL ACTIVITY—already rising as buyers rush in to beat the price increase — will keep moving up, primed by the $3,300,000,000 public-works program, of which $400,000,000 for highways will be passed out to 48 states within the next 60 days. Dollars paid for labor and equipment will circle back to boost factory operation.

• THIRD: INDUSTRIAL POWER LOADS will therefore keep on rising. Power units, long idle, must be tuned or patched for early operation. New capacity must be provided in many plants. It will cost more.

• FOURTH: POWER EXECUTIVES will find themselves in three classes. (1) those "sitting pretty" with plants ready to carry a growing load at high efficiency, (2) those who act now and thus get by without serious difficulty, although at some additional expense, (3) those who wait and get caught.

Chicago, June 25

● Chicago is the place, June 25 the date. Twenty engineering societies, thousands of engineers, will gather for a week of technical sessions. Right at hand will be the great Century of Progress exposition. In the Stevens Hotel will be held the sixth Chicago Power Show. *Power* will be there to report. Watch for the big story in July.

$200,000 to Find Out

● Another great research to lower power costs and safeguard life and property has reached its goal. Engineering Foundation announces completion of the research on arch dams. Time spent, ten years cost, $200,000.

Arch dams, bowed upstream to buck water pressure with the least amount of material, have long been used to cut construction costs. Yet, for lack of knowledge, they could not be completely figured. Designers played safe with excess material. Kilowatt-hours paid the bill.

Now, because the stresses in celluloid models have been checked against those in full-sized structures, other dams not yet built may be analyzed by testing such models. Even at $200,000, it's cheaper here to know than to guess.

Wanted—Smoke?

● Men sigh for the good old days of smoking factory chimneys. As usual they don't know what they want—it's work, not smoke.

Don't be fooled by a temporary lull in pure-air campaigns. Given a year or two of good business, the public cry for smoke elimination will rise again, louder than ever. It is therefore but elemental common sense to provide, as far as possible, for smokeless combustion and dust elimination in steam-generating equipment installed now.

Diesels on Duty

● By right of ability to perform, the diesel has won its place in industry. Section Two of this number proves it by a great table, listing important details of 115 American installations, all "depression babies" installed since Jan. 1, 1932.

The time has come when every steam engineer —whether his sphere is manufacturing plant, public building, institution, refrigerating plant, central station or municipal plant—must understand the diesel and its economic applications. The table will line him up on actual practice today.

So also will the leading article, describing 25 waste-heat installations. This is the first of a series showing just how, when and where diesel exhaust and jacket heat may be commercially salvaged in the form of steam, heated water or air.

Specify What You Want

● The man who asks for more than he wants either gets more than he wants or less than he asks for.

Many a power equipment buyer overlooks this fact. For example, he asks for quotations on a recording thermometer or control "accurate within one degree." Three degrees is close enough for the particular application, but he figures bidders will trim. Some do and some don't. The reputable maker bids high because he expects to deliver what's ordered—not something else. Thereby the buyer hurts himself and the fair bidder by unfairly restricting his choice. Sometimes all bidders take the buyer literally. Then he pays for what he doesn't need, and again he loses.

Moral: Specify what you want—no more. Make clear that the product will actually be checked against specifications. Follow through.

200 Roads to Air Comfort

● Nearly 200 concerns have taken up the manufacture of air-conditioning equipment. This places a heavy responsibility upon the engineer who must choose among innumerable systems.

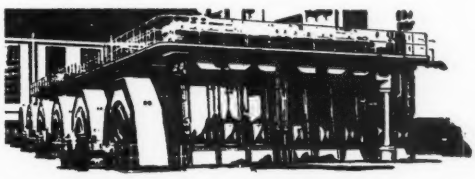
Each of these systems is the "best"—according to the man who sells it. Beyond any question, air conditioning is a coming thing, coming big and fast, but a lot of mistakes will be made by the unwary and uninformed.

For the engineer the only way out is the hard way. He must dust off the old study desk and master the subject from the ground up.

POWER Stands for

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of By-product Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

DOUBLE-ACTING DOLLARS

For  Fuel

DIESEL

Waste-heat recovery, from both jacket water and exhaust gases, can increase diesel station thermal efficiencies as much as 50 points. This first article of a series contributed to by more than 200 diesel manufacturers, operators and engineers, summarizes 20 actual installations where waste-heat recovery pays big dividends

DOES your diesel installation operate at a good load factor? Can you use hot water, hot air or steam at pressures up to 100 lb.? If the answer to both questions is "Yes," it will pay you to investigate the advantages of utilizing diesel waste heat.

Your engines operate at thermal efficiencies between 30 and 38 per cent; 5 or 6 per cent is lost in radiation; the remaining 56 to 65 per cent of fuel heat content is wasted in jacket water and exhaust gases. All the heat in the jacket water can be regained; at least half of that in the exhaust gases can be used. Only 10 to 15 per cent of total fuel heat content need be lost.

In Europe, fuels must be imported (thus national economics enter), are costly and competition between diesel and other prime movers is keen. There, many installations are making use of waste heat. Let's review several:

Schwerin Electrical Works, Germany, has three 800-hp. engines, a 700 and two 320—a total of 3,740-hp. Heat balance of the 800-hp. engines, for example, is: 31.5 per cent useful work, 39 per cent heat in cooling water, 24 per cent heat in exhaust gases, and radiation losses 5.5 per cent—or 68.5 per cent heat normally wasted. But not in this case! The works itself, a high school, several large residences and nearby banks—a total of nine large buildings—have been joined in a three-quarter mile piped circuit to utilize waste heat for heating. Jacket water, leaving the engines at 140 deg. F., is heated to 180 deg. in waste-heat boilers, then started on its circuit. Water returning from the circuit, if still too warm, is automatically sent to cooling equipment, then returned to the engines. But, meanwhile, it has given up enough heat to raise the thermal efficiency of the installation to 64 per cent. Maximum capacity of the installation is about 10,300,000 B.t.u. per hr., a waste heat recovery of about 2,750 B.t.u. per b.hp.-hr. After operating expenses and amortization, annual net earnings of more than 10 per cent on capital invested are realized, and heat is furnished to purchasers 20 per cent cheaper than with their former small plants, figured on a basis of coal consumption.

This is admittedly, a large installation, where waste heat utilization possibilities are extremely good. Many plants today average around 500-hp., in factories, apartments, hotels, and office buildings. So here is a British example, the plant of Summit Estates, Ltd., an apartment in Hyde Park, London. This plant has three 150-hp. engines. Jacket water heat is applied to building hot water, heat from the exhaust in heating the building.

The exhaust heat boiler used is really a water heater, and comprises a horizontal shell 4 ft. in diameter by 8½ ft. long, containing a double pass of fire tubes to give a total heating surface of 430 sq.ft. According to recent tests this boiler salvages an average of 13,250,000 B.t.u. per day. Assuming that this heat would otherwise have been supplied by additional coke of which each pound delivers about 7,500 B.t.u. to the water, the boiler saves about 5½ tons of coke per week.

Heat rejected to engine jackets is used in the building hot-water system by means of a heat exchanger. This

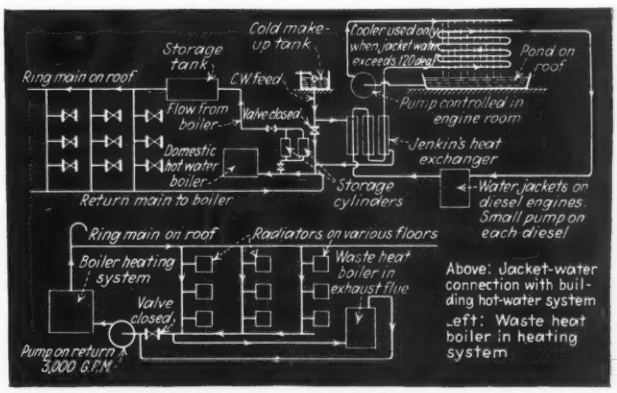

Cold make-up tank
Cooler used only when jacket water exceeds 120 deg F
Storage tank
Pond on roof
Ring main on roof
C.W. feed
Flow from boiler
Valve closed
Pump controlled in engine room
Jenkin's heat exchanger
Domestic hot water boiler
Return main to boiler
Storage cylinders
Water jackets on diesel engines. Small pump on each diesel
Ring main on roof
Radiators on various floors
Boiler heating system
Waste heat boiler in exhaust flue
Valve closed
Pump on return 3,000 G.P.M.
Above: Jacket-water connection with building hot-water system
Left: Waste heat boiler in heating system

Fig. 1—Waste-heat installation of Summit Estates

exchanger increases building circulating water temperature 44 deg. F., saving 460,000 B.t.u. per day or the equivalent of 2 tons of coke per week. The jacket-water circuit includes roof automatic atmospheric cooler, used only when engine jacket-water temperature exceeds 120 deg. F.

These installations show reasonable waste heat recovery—neither is unusually high. A small south-German textile plant gets a thermal efficiency of 84.8 per cent! Both exhaust gases and jacket water of its 1,200-hp. diesel engine are used in heat recovery equipment.

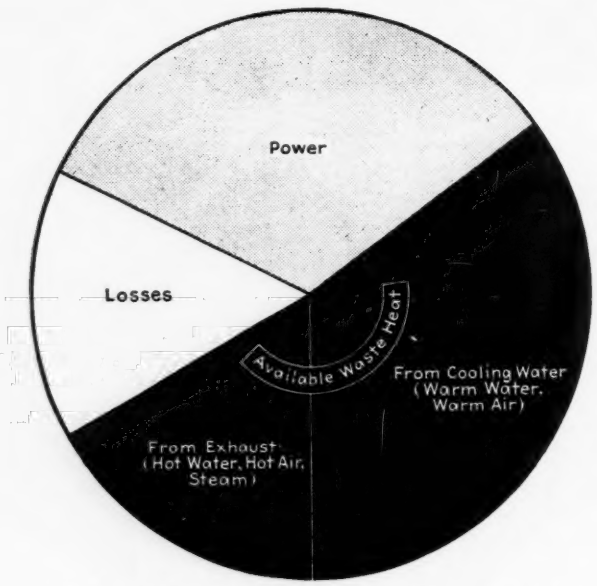


Fig. 2—The possibilities of waste-heat utilization

Tests show that 31.1 per cent of the heat in fuel is expended in useful work, 40.8 per cent recovered from the jacket water and 12.9 per cent from the exhaust gases, and only 15.2 per cent is lost. This is at full load; at three-quarter load, utilization drops to 83.6 per cent, at half-load, 80.3 per cent.

As to small installations—another German industrial plant has a 73-hp. engine. Heat expended in useful work is 34 per cent, heat in cooling water and exhaust gases regained is 50 per cent, leaving only 16 per cent irrecoverable.

The 450-hp. plant of Hamburg-American Clock Works at Schramburg, Wurttemburg, uses only part of its waste heat. Exhaust gas heat is utilized to heat air for a timber-drying chamber. Tests show 54 per cent of the heat in fuel utilized at full load, 55 at three-quarter load and 50 at half load. Heat in the cooling water, totalling 39 per cent of the heat in the fuel, is not utilized. Exhaust gases take about 28 per cent of the heat input, and of this 76 per cent is utilized at full load, 80 per cent at three-quarter load, and 61 per cent at half load.

These installations are fairly typical of European practice, but waste-heat utilization in any sense is uncommon in this country because of relatively lower fuel costs and other factors. With a realization of the tremendous possibilities of waste-heat utilization where properly applied, the editors of *Power* have been preparing a series of articles on the subject, of which this is the first. Information incorporated in the series has been gained from all American diesel manufacturers, important foreign builders, notable American installations utilizing waste heat and available printed information—some 200 reference sources in all. Three general subjects will be discussed, typical installations, theory and possibilities of waste-heat utilization, and equipment available.

Among American diesel stations in which waste heat is utilized, probably most outstanding will be the installation at Vernon, Calif., this country's largest diesel station. No data is available on this installation at this writing. Second largest American station using waste heat is Rockville Center, L. I., with a 2,865-hp. unit, three 1,250 and one 850. Exhaust gases pass through water-cooled manifolds to the basement. Here a three-way valve was formerly employed to pass the gases either through silencers or into the steam-heating boilers This method was not satisfactory. This problem has been solved by determining through experience the quantity of exhaust gas necessary for requirements, and controlling this quantity with an orifice in the pipe line to the boiler. Waste-heat boilers supply all heating requirements of the building. They were built for 15-lb. working pressure, but usually do not have to be operated at more than 0.5 lb. Steam thus produced is also used for hot water supply and in cleaning lubricating oil monthly. Oil is pumped into a basement tank containing steam coils, heated to 180 deg. F., then centrifuged.

After extensive cost comparisons, Pan Corp., Union Stockyards, Chicago, decided to install a 3,000-hp. diesel to correct the heat balance of Morgan St. plant. The old steam plant was generating only about 30 per cent of the power required, while the remaining 70 per cent was purchased, with the utility carrying most of the peak load—at high unit cost. The diesel could be fitted into the space available and would take the peak load. Waste heat, (amounting to 30.9 per cent in cooling water and 32.3 in exhaust gases) recovered for use as boiler feed water, amounts to 38 per cent. Jacket water at 140 deg. is heated to 180 deg. in a waste heat boiler (one of the old plant boilers) using engine exhaust. It then passes to the feed-water heater or to return through an automatic bypass into the yard's flushing system reservoir. By this system, no water is wasted and there is a recovery of about 9,000,000 B.t.u. per hr. or an equivalent of 1,065 lb. of coal per hr., a saving of $7,600 per year. (See *Power,* December, 1932, page 299.)

The automatic diesel plant at No. 1 Park Avenue, New York City, recirculates cooling water from its four 270-hp. engines. Part of the warm water leaving engine jackets is picked up by a small motor-driven centrifgual pump and returned to jacket inlets, the amount being controlled by a thermostatic valve in the make-up line. Thus, when the units are started, almost all of the jacket water is recirculated until the temperature reaches 115 deg., when the make-up valve opens to admit more cold water. Outlet jacket water, at about 135 deg. F. is used

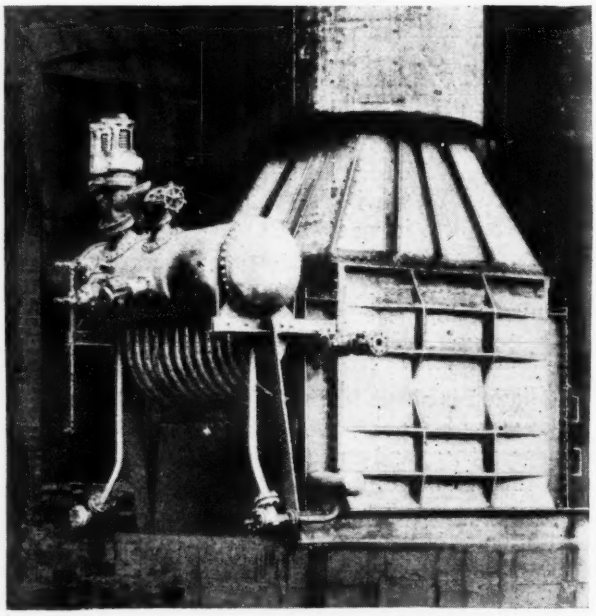


Fig. 3—A waste-heat boiler installed outside the plant it serves

in the building hot-water supply system. By metering, it has been determined that the value of the heated water supplied to the building from the diesel plant is equivalent to the entire cost of the water supply from the city mains for the plant circulating system. Building heating is provided for, and more than enough hot water is available, so exhaust gas heat is not utilized. Two 300-hp and a 120-hp. engine form the new Kenyon, Minn., diesel station. Temperatures often reach thirty below there, and large window areas make station heating difficult. Insulated enclosures have been built around the exhaust silencers within the building walls. A blower draws air through louvres, passes it over silencers and part of the exhaust line, and forces it out into the room again. Since no silencing pit is used, the exhaust lines (at about 400 deg.) are run through a trench in the middle of the floor, with grilles over it to permit the heat to pass into the room.

Blooming Prairie, Wells, and Delano, Minn., likewise have temperatures of twenty below and worse, but in each case, unit heaters through which hot circulating water is pumped provide sufficient heat for engine room, office, and storeroom. Last winter, all these stations held temperatures of 70 deg. or hotter, with the mercury at twenty below outside. Further south, at Ellis, Kans., the same system is used. With half load on the 500-hp. engine, they report 10 lb. of steam on their waste-heat boiler, even with the unit-heater fans on high speed. The boiler acts as a heat storage for as long as 12 hr. after the engine has been shut down.

Bloomington, Ill., with three 750-hp., 2-cycle engines uses exhaust heat for the powerhouse heating and ventilating system, and hot jacket water for usual lavatory uses. Waycross, Ga., with a 120-hp. engine, uses a closed system, cooling water from the mains being circulated through a heat exchanger to pick up jacket water heat. Then it is run into a storage reservoir, with a bypass to the old standby boilers, which also act as heat storage.

Occasionally, waste-heat boilers are placed in the open,

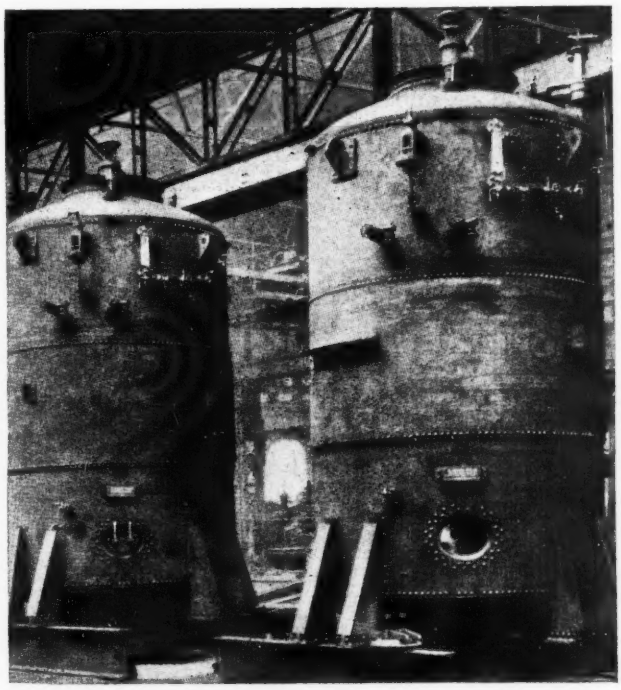


Fig. 4—The two 5,000-sq.ft. waste-heat boilers for the *M. V. Georgic*

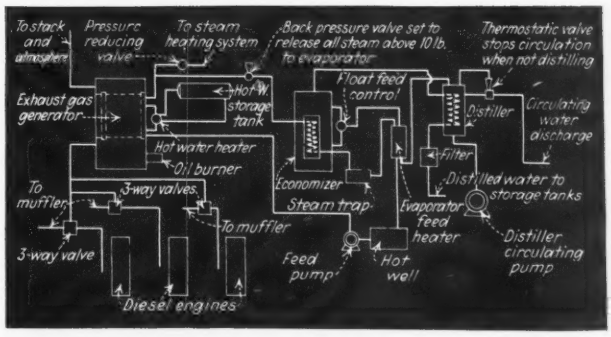


Fig. 5—Waste-heat installation aboard the "Aloha"

outside the building housing the boilers they serve. The installation of this type illustrated is a 1,400-sq.ft. (extended heating surface) boiler serving a 4,000-hp. double-acting, 4-cycle engine. Steam is produced at 43.5 in. gage, with back pressure on the engine exhaust of 6 in. water gage. Gases enter the boiler at 538 deg. F. and leave at 346, while water enters the boiler economizer at 168 deg. F. Exhaust gases run 85,000 lb. per hr., water to the boiler, 2,820.

Most motorships utilize all waste heat, and are far ahead of land stations in this respect. Largest waste-heat installation is that of the *M.V. Georgic,* new White Star liner. Two thimble-tube boilers serve the two 10,000-hp. main engines. The 900-sq.ft. boilers are 9 ft. in diameter and 18 ft. 2 in. high. Each develops 5,000 lb. of steam per hr. at 100 lb., which is used for heating the 27,700-ton ship by means of unit heaters. Two smaller boilers take gasses from the four 750-hp. and four 900-hp. auxiliary engines. Each is $6\frac{1}{4}$ ft. in diameter and $11\frac{1}{2}$ ft. high, with 300 sq. ft. of heating surface, to develop 1,800 lb. of steam per hr. Thus total steam available is about 13,600 lb. per hr., saving about 13.6 tons of boiler oil per day.

A much smaller installation is that on the "Aloha," which has three 300-hp. engines. The installation provided is of smaller capacity, since full engine power is rarely used. With one engine at 75 per cent load, the waste heat recovery system picks up 560 B.t.u. per b.hp.-hr., with two engines developing 402 hp. it regains 530. Heat from one engine will distill 14 gal. of sea water per hr., heat 198 gal. of water from 60 to 140 deg. F., or supply heat for 530 sq. ft. of radiation.

With 2-cycle engines, exhaust temperatures are lower and heat reclaimable is likewise lower. The tankship *Willhelm A. Riedemann* has two 2-cycle, air-injection engines providing 1,650 effective hp. Tubular waste-heat boilers of 600 sq.ft. each are equipped with suitable preheaters. Operating pressure is 90 lb. per sq.in. Exhaust gas temperature is 338 deg. before the boilers, 225 after the boilers, and 215 after feed-water preheaters. About 13 per cent of the heat in fuel is regained. Another tankship, *Geo. W. McKnight,* has two solid-injection 2- cycle, diesels developing 2,250 b.hp. Each engine has a 550-sq.ft. waste heat boiler with feedwater preheater, and generates steam at 105 lb. gage. Exhaust temperature is 275 deg., 220 deg. after the boilers and 130 after the feed-water preheaters. About 11 per cent of the heat content of the fuel oil is regained.

Often, waste heat has not been utilized where it might prove exceedingly economical. Later articles will analyze the problem of utilization, describe suitable waste-heat recovery units, and will include a table of 50 or more typical stations utilizing waste heat.

ENGINEERS
CHICAGO
JUNE 25-30

This month, "Chicago" means the great Century of Progress Exposition. To engineers it also means a gathering of their clan that may well be the greatest in the World's history

DURING "Engineering Week," June 25 to July 1, nineteen engineering associations will hold sessions—at least sixty in all. And on June 28, "Engineer's Day," all of these groups will come together in Soldier's Field, Chicago's great stadium, for spectacular and significant ceremonies. In the same week, the Sixth Midwest Engineering and Power Exposition will be held at the Hotel Stevens.

To report these great events *after* they have happened, *Power's* major treatment of Chicago activities will be reserved for the July number. Editors will comb the many engineering sessions for facts and ideas of practical value to power men everywhere. They will seek out among thousands of exhibits in the Century of Progress Exposition those of peculiar interest and value to power men in their professional rôles.

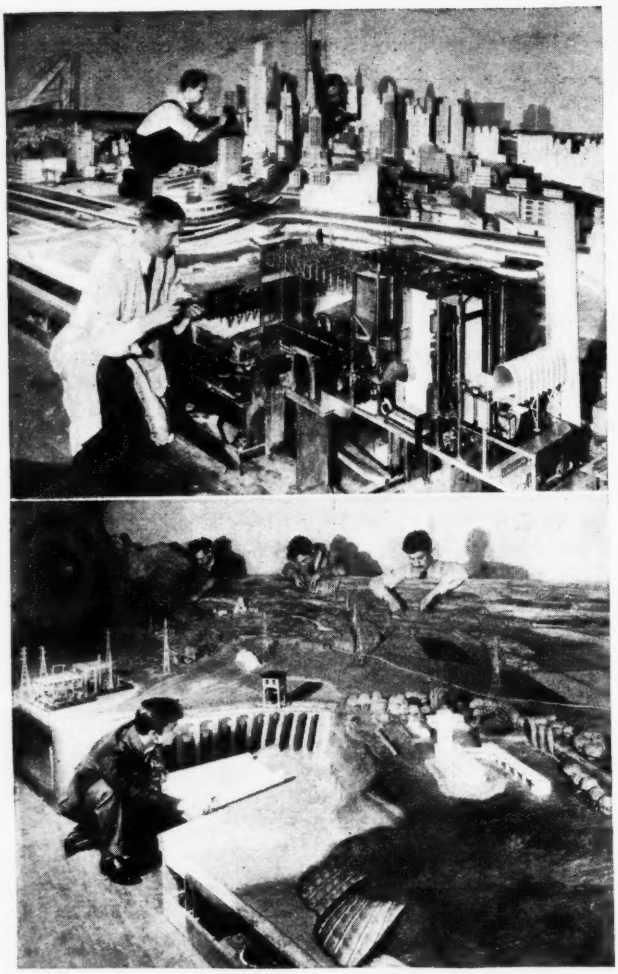
Many pages of the July number will be devoted to these Chicago events. The present brief article will merely outline the events of "Engineering Week" most likely to interest the power engineer and give the reader a hint or two of the glories of the Exposition.

Over a period of five months, June 1 to Oct. 31, the Century of Progress Exposition will be visited by millions, before whom will be spread a vast panorama of modern wonders.

On the one hand will be sections devoted to the fundamental sciences: physics, chemistry, mathematics, biology, etc. On the other will be shown their applications in engineering, medicine, agriculture and architecture.

And everywhere will be power, both before the eyes and behind the scenes. For the whole Exposition is, in a sense, a great power exhibit, requiring more than 35,000-kw. to operate its spectacular lighting, its motors and its innumerable electrical devices. Moreover, power exhibits, as such, have a prominent part in the exposition.

Extending several miles along the shore of Lake Michigan, literally in Chicago's front yard, the Exposition will surround a great lagoon and stand entirely on made land. Magnificent structures, windowless, will carry the colors of the rainbow.



Constructing two sections of the great diorama being exhibited by the Electrical Central Station Industry at the Century of Progress. Above is a model steam generating station, below a low-head hydro plant.

In the electrical group, a great diorama, 90-ft. long, will portray the generation, transmission and application of electricity. By exhibits, lectures, motion pictures and demonstrations, numerous manufacturers will display the wonders of science, commercially harnessed for the service of man.

On the next page are listed organizations participating in "Engineering Week." Still another table lists, as far as titles are now available, papers of particular interest to power engineers.

An additional word should be said about "Engineers' Day," June 28. Juan De LaCierva, inventor of the Autogyro, will fly his machine to Chicago and land at Soldier's Field, in the midst of assembled engineers. It is expected that more than 15,000 engineers will witness this and hear the addresses that will follow.

In the evening a joint banquet, with international notables present, will be held. All societies will cooperate in this banquet, which will be the greatest ever held endorsing engineering principles and progress.

July *Power* will Report:

Century of Progress Exposition
Engineering Week
Mid West Power & Engineering Exposition
World Power Conference at Stockholm

ENGINEERS' WEEK POWER PAPER PROGRAM

MONDAY, JUNE 26

9:30 a.m. A.S.M.E. Palmer House.
Fuels: A Century of Progress in Fuel Technology, O. P. Hood.
Steel: Plastic Deformation Symposium (three papers).
Boiler Feed Water: Effect of Suspended Solids, Report Sub-Comm. No. 31 and three other sub-committee reports.

2:00 p.m. A.S.R.E. Hotel Sherman.
Gas Engine Drive, C. T. Baker.
Condenser Design, H. C. Guild.
Brine Flow in Pipes, H. J. MacIntire.

2:00 p.m. S.P.E.E. Stevens Hotel.
Conference on Cooperative Engineering Education.

2:00 p.m., A.S.T.M. Stevens Hotel.
Report A.S.T.M. and A.S.M.E. Research Committee on Effect of Temperature on Properties of Metals.
Creep and Structural Stability of Nickel-Chromium-Iron Alloys at 1,600 deg. F., W. A. Tucker, and S. E. Sinclair.
Studies on Creep of Metals Using a Modified Rohn Test, C. R. Austin.

2:15 p.m. A.S.M.E. Palmer House.
Fuels: Standby and Reserve Operation of a Pulverized-Fuel Plant, E. H. Tenney.
Oil Firing in Pulverized-Coal Furnaces, James F. Muir.
Education and Training: Two papers.

TUESDAY, JUNE 27

9:30 a.m., A.S.M.E., Palmer House.
Fuels: Correlation of Grindability with Actual Pulverizer Performance, Martin Frisch.
Principles of Underfeed Combustion and Effect of Preheated Air on Over- and Underfeed Fuel Beds. P. Nicholls.

9:30 a.m., A.S.T.M., Stevens Hotel.
Fifth Session: Report of Sectional Committee on Standardization of Dimensions and Materials of Wrought Iron and Wrought Steel Pipe and Tubing.
Sixth Session: Report Committee C-8 on Refractories.

9:30 a.m., A.I.E.E., Edgewater Beach Hotel.
Protective Devices: Testing High-Speed Distance Relays, E. E. George and W. R. Brownlee; Relaying High-Voltage Interconnection, H. P. Sleeper.
Arc Extinction in High-Voltage Circuit Breakers Studied with Cathode-Ray Oscillograph, R. C. Van Sickle and W. E. Berkey.
Interrupting-Capacity Tests on Circuit Breakers, R. M. Spurck and W. F. Skeats.
Present Practice on Installation and Performance of High-Voltage Lighting Arrestors, A.I.E.E. and N.E.L.A. Subcommittees.
Instruments: Recent Developments in Sound Measurement, H. B. Marvin.
Portable Oscillograph With Unique Features, K. A. Oplinger.

10:00 a.m., A.S.R.E., Hotel Sherman.
High-Speed Conditioning Units, C. R. Neeson.

2:00 p.m., S.P.E.E. Stevens Hotel.
Conference on Cooperative Engineering Education.

2:30 p.m., A.S.M.E., Palmer House.
Applied Mechanics: Influence of Lashing and Centrifugal Force on Turbine-Blade Stresses, R. P. Kroon.
Effect of Openings in Pressure Vessels, J. Hall Taylor.
Smoke Abatement: Measurement of Properties of Cinders and Fly Ash, A. C. Stern.
Progress in Removal of Sulphur Compounds from Waste Gases, H. J. Johnstone.
Human Side of Smoke Abatement, W. G. Christy.

2:30 p.m., A.S.R.E., Hotel Sherman.
Humidity and Heat Flow, W. R. Woolrich.
Thermodynamics of SO_2-Oil Systems, L. A. Philipp.
Absorption Refrigeration with Solid Absorbents, F. R. Bichowsky.

2:30 p.m., N.D.H.A., Palmer House.
Comparison of Design Methods for Distribution Systems, R. M. Nee, L. D. Gray and G. K. Sauerwein.
Comparison of Construction Methods for Distribution Systems, L. D. Gray, R. M. Nee and G. K. Sauerwein.
Line Loss and Delivery of Superheated Steam, P. F. Helm.
Distribution Line Loss and Unaccounted for Steam, E. Lenz.
Comparison of Operating and Maintenance Methods of Distribution Systems, J. J. Schenk, H. Warhanek and G. D. Winans.
District Heating Distribution System Construction in Washington D. C., A. J. Slade.
Meter Committee Report, E. A. Lueky.

3:30 p.m., A.S.T.M. and A.A.A.S., Stevens Hotel.
Edgar Marburg Lecture, Crystalline Structures in Relation to Failure of Metals, Especially by Fatigue, H. J. Gough.

8:00 p.m., A.A.A.S., A.S.M.E., Palmer House.
Industrial Developments of the Century, A. P. M. Fleming.

WEDNESDAY, JUNE 28, ENGINEERS DAY

9:30 a.m., N.D.H.A., Palmer House.
Report of Research Committee, G. K. Sauerwein.
Report of Research Sub-committee on Corrosion, J. H. Walker.
Report of Station Engineering Committee, H. J. Bauer.
Principles of Gas Washing Applied to Sulphur Dioxide Removal, H. F. Johnstone.
Determining Factors in Feed-water Treatment for Plants Using Large Quantities of Make-up, S. T. Powell.
Recent Developments in Fuel-Burning Equipment, J. R. McCausland.
Utilization of Competitive Fuels, George Orrok, Jr.
Comparative Study of By Product Generating Cycles, R. G. Felger, M. W. Benjamin.

10:00 a.m., Soldiers Field.
Presentation of Daniel Guggenheim Medal-Stadium.

7:00 p.m., Stevens Hotel.
Joint Engineering Dinner.

THURSDAY, JUNE 29

9:00 a.m., S.P.E.E., Stevens Hotel.
Professional Development of The Engineer, R. I. Rees.

9:30 a.m., A.S.M.E., Palmer House.
Application of High-Boiling-Point Organic Compounds to Industrial Heat-Exchange Problems, J. J. Grebe and E. F. Holser.
A Graphical Method for the Design of Flexible Members for Steel Piping, E. A. Wert, S. Smith, E. T. Cope.

9:30 a.m., A.S.C.E., and A.S.M.E. Palmer House.
Flow of Water Around Bends in Open and Closed Channels, David L. Yarnell.
Report of Power Committee on Legislation Respecting Safety of Dams.

9:30 a.m., A.I.E.E., Edgewater Beach Hotel.
Expulsion Protective Gap, K. B. McEachron, I. W. Gross, and H. L. Melvin.
De-Ion Flashover Protector and Its Application to Transmission Lines, A. M. Opsahl, J. J. Torok.
Design Features of Port Washington Power Plant, G. G. Post.
Beauharnois Development of the Soulanges Section of the St. Lawrence River, W. S. Lee.

CONVENTIONS

Chicago, June 26 to 30

American Association for the Advancement of Science.
American Association of Engineers.
American Ceramics Society.
American Foundrymen's Association.
American Institute of Electrical Engineers.
American Institute of Mining & Metallurgical Engineers.
American Society of Civil Engineers.
American Society of Mechanical Engineers.
American Society of Municipal Engineers.
American Society for Testing Materials.
American Society of Agricultural Engineers.
National Council of State Boards of Engineering Examiners.
Society for the Promotion of Engineering Education.
Society of Industrial Engineers.
Institute of Radio Engineers.
Western Society of Engineers.
American Society of Refrigerating Engineers.
American Welding Society.
National Industrial Advertisers Association.
National District Heating Association.

9:30 a.m., A.S.T.M., Stevens Hotel.
Eighth Session:—An "Overnight" Test for Determining Endurance Limit, H. F. Moore.
Ninth Session:—Report of Committee D-5 on Coal and Coke.
Study of Adsorption as a Method for the Determination of the Surface of Pulverized Coal, R. A. Sherman.
Agglutinating Value Test for Coal, W. A. Selvig.
Report of Committee on Classification of Coals.

10:00 a.m., A.W.S., Congress Hotel.
Three papers.

2:15 p.m., A.S.M.E., and A.S.C.E. Palmer House.
Resumé of Engineering Reports on St. Lawrence Power Development, Daniel W. Mead and T. H. Hogg.

2:00 p.m., A.S.T.M., Stevens Hotel.
Report of Committee A-5 on Corrosion of Iron and Steel.
Data Showing Influence of Water Velocity and Time on Corrosion of Iron, R. F. Passano and F. R. Nogley.

7:00 p.m., S.P.E.E., Stevens Hotel.
Annual Dinner—Personalities of Engineering Educators, G. C. Anthony.

FRIDAY, JUNE 30

8:30 a.m., N.D.H.A. Palmer House
Report of Operating Statistics Committee, A. D. Leach.
Report of Hot-Water Committee, Henry Meyer.
Progress Report of Pure Air Committee of the A.S.M.E., M. D. Engle.

9:00 a.m., S.P.E.E., Stevens Hotel.
New Opportunities for Technical and Engineering Graduates.

9:30 a.m., A.S.M.E., Palmer House.
Performance of Two 101,000-sq.ft. Surface Condensers, J. N. Landis.
Surface-Condenser Design and Operating Characteristics, Townsend Tinker.
Thermal Study of Available Steam-Power Plant Heat Cycles, G. A. Hendrickson and S. T. Vesselowsky.

9:30 a.m., A.S.C.E. and A.S.M.E., Palmer House.
Water Hammer Symposium, eight papers covering theory, water hammer formula, high head penstock design, influence of water hammer on design at Drum Plant and Tiger Creek plant, computation of water hammer pressures, effect of surge tanks on water hammer computations, surge control in centrifugal pumps discharge and water hammer tests at Croton Lake Pumping plant. Authors include S. Logan Kerr, L. F. Moody, A. W. K. Billings, Walter Dreyer, R. E. Glover, E. E. Halmos, and R. S. Quick, continued to afternoon session.

9:30 a.m., A.S.T.M., Stevens Hotel.
Comparison of Certain White Metal Bearing Alloys Particularly at Elevated Temperatures, C. E. Swartz and A. J. Phillips.

9:30 a.m., A.I.E.E., Edgewater, Beach Hotel.
Improvements in Mercury-Arc Rectifiers, J. H. Cox.
Obtaining Comfort Conditions by Controlled Radiation from Electrically Heated Walls, L. S. Shadt.

2:15 p.m., A.S.M.E., Palmer House.
Characteristics of Large Hell Gate Direct-Fired Boiler Units, W. E. Caldwell.
Study of Calcium-Sulphate Scale Prevention at Higher Steam Pressures, F. G. Straub.
Moisture Problem in Steam Turbines, C. R. Soderberg.

2:15 p.m., Auspices Econometric Society, jointly with A.S.M.E., A.S.C.E., A.I.E.E., A.S.T.M., Palmer House.
Rational Basis for Interpreting Economic and Engineering Data, Thornton C. Fry.
The Engineering Economist of the Future, Dexter S. Kimball.

2:15 p.m., A.S.C.E. and A.S.M.E., Palmer House.
Hydraulic: Continuation of Water Hammer Symposium.

8:00 p.m., Econometric Society jointly with A.S.M.E., A.S.C.E., A.I.E.E. and A.S.T.M., Palmer House.
Some Fundamental Problems of the Engineer, Dr. F. B. Jewett.
Internationalization of Scientific Knowledge as a Factor in World Economic Recovery, A. P. N. Fleming.

Courtesy Swedish Consulate, New York City

"On to Stockholm" for the WORLD POWER CONFERENCE

VARIOUSLY described as the "Venice of the North" and the "World's Most Civilized City," Stockholm is known to all world travellers as a city of rare charm. Grouped on a series of islands, the Royal Palace, the House of Parliament, magnificent hotels and business buildings are framed among the masts of ships that lie almost in their "front yards."

In this high latitude, twilight extends far into the cool summer night, particularly around the end of June. No more congenial place or time could have been chosen for the 1933 Sectional Meeting of the World Power Conference, whose principal sessions will be held in the House of Parliament.

Events will thus center in Stockholm, but other parts of Sweden and other northern countries will be visited by the delegates. Trips for pleasure and information will be made to Norway, Denmark and Finland. The principal dates and places are listed on the accompanying summary of the program.

MAIN PROGRAM

June 26 (Mon.) and 27, Copenhagen: Reception, lectures, official dinner, excursions.
June 28 through July 4, Stockholm: Technical sessions, with parallel meetings of Congress on Large Dams.
July 5 and 6: Study Tours in Sweden.
July 7 and 8: Norway, in and around Oslo: Excursions, reception, final sessions and dinner.
July 9, Norway: Excursions.

TOURS
(In addition to short excursions)

July 1-3, Week-end trip to Finland.
July 3-7, Large Dam Congress Tour.
July 5-7, Wood and Pulp Industry.
July 5-7, Iron and Steel Industry.
July 4-7, Railway Electrification.
July 4-7, Shipbuilding Industry.
July 5-7, Power Plants and Machine Industry.
July 9, Tours in Norway.

SUBJECT PROGRAM
W. P. C. Sections

1. Energy Supply
2. Power and Heat Combinations
3. Special Energy Problems of the Steam Heat Consuming Industries
4. Special Energy Problems of the Iron and Steel Industry
5. Electrical Heating
6. Motive Power for Industrial Machinery
7. Railway Transport
8. City and Suburban Transport
9. Marine Transport

Congress on Large Dams

1a. Ageing of Concrete
1b. Distortions in Gravity Dams
2a. Earth Dam Material
2b. Infiltration Through Earth Dams

As part of the conference, but in separate meetings, will be held the sessions of the First International Congress on Large Dams. Regular meetings of the Congress will devote one session to each of the nine listed sub-divisions of the power problem, of which the first seven will be of particular interest to *Power* readers.

In all more than 170 papers will be presented, of which 9 (listed on page 217 of the April *Power*) are sponsored by the American Committee.

Many of the papers, both American and foreign, will contain information of considerable value to American engineers, particularly to those concerned with industrial power problems and the interrelation of power, process heat, waste heat and the tying together of industrial power plants and central stations. It is expected that many of these papers will be ready for summarizing in the July number of *Power*.

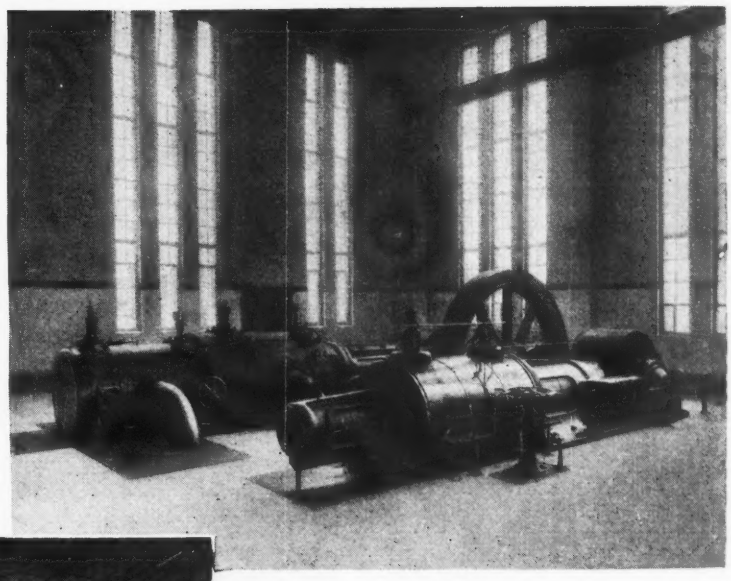
The history of the World Power Conference from the start has been notable for its achievements in the field of International Cooperation. In its Conferences at London (1924) and Berlin (1930), and in its sectional meetings at Basle, London, Barcelona and Tokio, engineers of all nations have fraternized and exchanged ideas in an atmosphere of complete friendliness. Beyond question, the Stockholm sectional meeting will strengthen these bonds. When this has passed, American engineers may look forward to the holding of the third plenary conference in their own country, probably in 1936.

At that time, revived business and industry should make it possible for many engineers to cross the Atlantic and Pacific to meet in the New World. American engineers will welcome their opportunity to entertain foreign guests of kindred mind and to profit from the resulting stimulating contacts with new friends and new ideas.

The American Committee is headed by O. C. Merrill, Chrysler Building, New York, to whom requests for further information may be addressed.

In addition to Mr. Merrill, Americans attending the Conference will include: V. E. Bird, president of Connecticut Power Co.; A. C. Hobble, Barcelona; C. E. Magnusson, University of Washington; D. B. Rushmore, New York City; Robert Sibley, University of California; A. R. Smith, General Electric Co.; Prof. G. L. Tuve, Case School; Chilton A. Wright, Bureau of Standards; Henry J. Pierce (London) Vice-Chairman of American Committee; Glennon Gilboy, Massachusetts Institute of Technology.

WORLD'S LARGEST REFRIGERATING COMPRESSOR



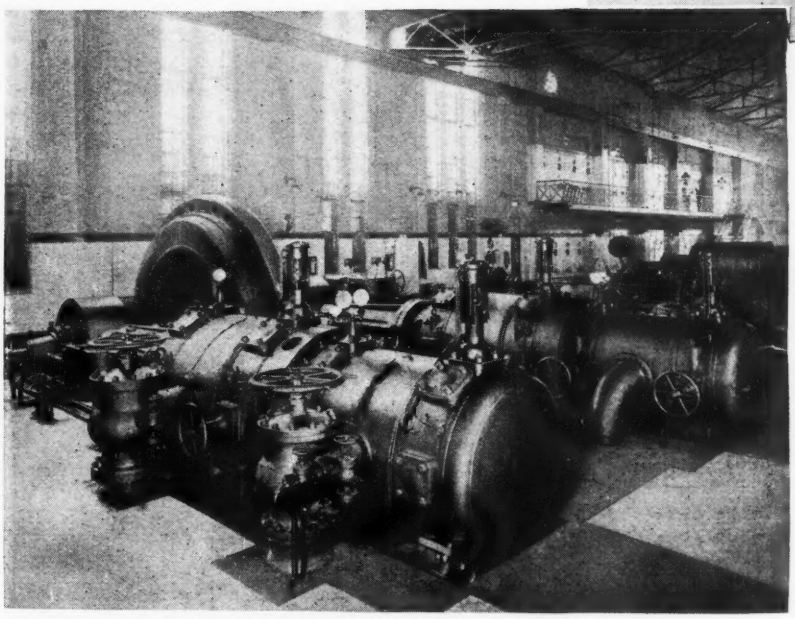


Fig. 1 (Above)—This two-stage ammonia compressor, direct driven by steam engine, had a rated capacity of 1,330 tons of refrigeration. After conversion, its capacity was increased to 2,700 tons

Fig. 2 (Left)—The world's largest reciprocating refrigerating compressor, converted by replacing the steam engine cylinder of the unit above with two compressor cylinders, one behind the other, and driving with an asynchronous motor

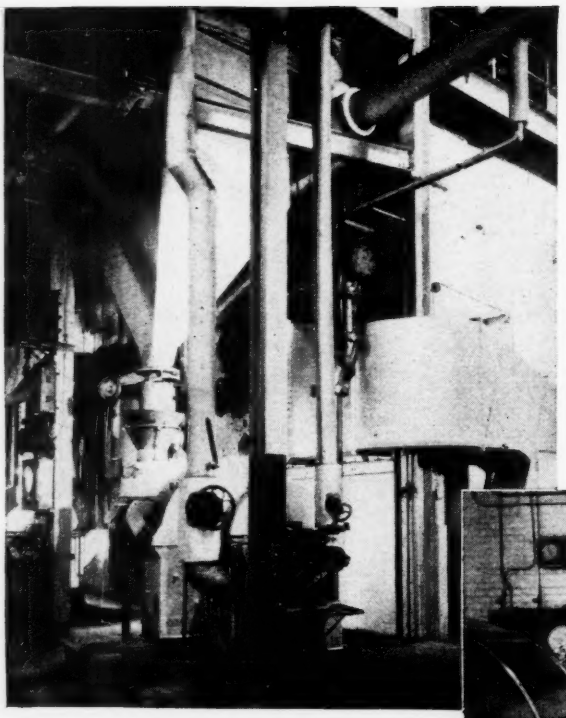
WHEN refrigeration was taken up by the chemical industry a few years ago in connection with the manufacture of certain salts precipitated only at low temperatures, the largest refrigerating machines hitherto used were not capable of removing the required quantity of heat. For example, the Wintershall Trust, in manufacturing Glauber's salt at their Merkers works, Germany, required that about 12,000,000 B.t.u. per hr. be removed in order to produce a certain quantity of salt by the continuous freezing process. For this purpose, Sulzer Brothers supplied a two-stage reciprocating ammonia compressor with a rated capacity of 16,000,000 B.t.u. per hr., equivalent to 1,330 tons of refrigeration. The compressor was direct-driven by means of a single-cylinder, back-pressure steam engine with a maximum output of about 1,200 b. hp. at 150 r.p.m. The complete set is illustrated in Fig. 1.

Soon afterwards, the increasing demand for refrigeration made an extension of the refrigerating plant necessary. Erection of a second similar compressor set with a steam engine could not be considered, since the space required for it was not available. The problem of increasing the refrigerating capacity to 32,000,000 B.t.u. per hr. (about 2,700 tons of refrigeration) was solved by converting the existing set. The converted set, largest refrigerating compressor in the world, is shown in Fig. 2.

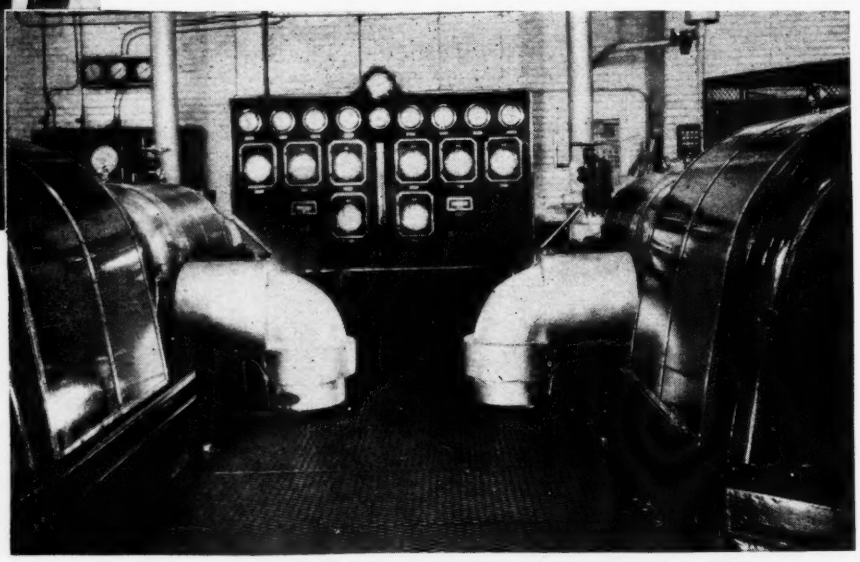
Conversion was effected by removing the cylinder of the steam engine and erecting in its place two compressor cylinders, arranged one behind the other and of the same size as the already existing cylinders. The compressor is now driven by an asynchronous flywheel motor mounted on the crankshaft and having a continuous output of 2,200 b.hp. at 158 to 152 r.p.m.

All cylinders are fitted with light disk valves, one of which at each end of each cylinder can be put out of action, thus enabling the capacity of the compressor to be adjusted within wide limits. In addition, each cylinder is fitted with a safety by-pass valve, connecting the suction and pressure sides to each other. These valves allow the compressor to be started without load and are opened or closed in accordance with the adjustment of a cock fitted on the service side of the compressor. Bearings and connecting rods are automatically lubricated by a gear-wheel pump driven from the crankshaft. This pump also supplies the oil under pressure required for operating the safety by-pass valves. Cylinders and stuffing-boxes are lubricated by Bosch lubricators. To facilitate removal and erection of the pistons, the high-pressure cylinders are fitted on a plate, on which they can be withdrawn axially by means of worm drive.

POWER BUILDS INSTRUMENTS;

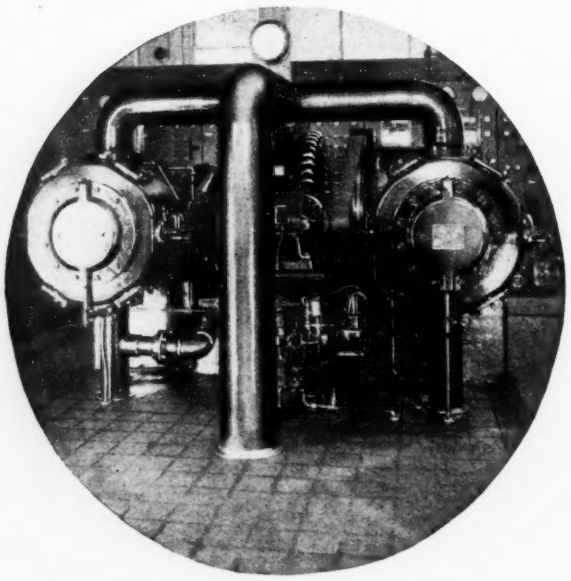


I (Left)—IN 1930 THE TAYLOR INSTRUMENT COMPANIES, Rochester, N. Y., were faced with a power problem. The four old return-tubular boilers (120-lb.) were being forced to capacity. Actual evaporation ran about 8.5 lb. Steam costs were too high. Two new 415-lb. pressure water-tube, pulverized-coal-fired boilers were ordered, the first (here shown) taking load Sept. 1, 1931.



II (Right)—TWO 750-KVA. TURBINES replaced old Corliss sets (250-kw. and 75-kw.). To avoid shutdown the small Corliss was removed first, making space for both turbines. Turbine No. 1 started up with the new boiler No. 1. Boiler No. 2 and turbine No. 2 were cut in Feb. 1, 1932. Service was continuous during the change-over.

III (Below)—A TWIN-CYLINDER AIR COMPRESSOR, synchronous-motor-driven, was put in to deliver 1,185 C.F.M. of 25-lb. air. Another tandem steam-air unit was electrified with multiple Vee belt drive. New motor-driven heating return pumps and feed pumps were installed, also hot-process softener, deaerating feed heater, desuperheater, and other auxiliaries.



Mechanical and Electrical Equipment

Boilers: Two (ult. 3) Connelly (now Foster Wheeler) 3-drum, bent-tube, 5,170-sq.ft. each. Steam 415-lb. gage. Max. capacity 45,000-lb. per hr. Equipped with Yarway blow-off valve and water cols. and Consolidated safety valves.

Superheaters: Foster Wheeler for 600-deg. steam temp.

Furnaces: DeWolf, air-cooled wall, 3500 cu.ft.

Burners: One per furnace, Riley Stoker Corp.

Pulverizing Mills: One per boiler, Riley "Attrita," 6,000-lb. per hr. dual drive by 40-hp. G.E. motor and Moore 75-hp. turbine. Mills and furnaces cross-connected.

Forced-Draft Fans: (Secondary Air)—Two Buffalo Forge No. 7, driven by 20-hp. G.E., wound-rotor motors.

Induced-Draft Fans: Pratt-Daniel, 30-hp., 870 r.p.m., motor-driven (space for turbine), combined with cinder eliminator.

Hot-Process Softener: Deaerating heater, Cochrane Corp.

Boiler-Feed Pumps: Two Moore, 4-stage centrifugal, 45-g.p.m. against 480-lb., one driven by Moore 55-hp. turbine at 3,500-r.p.m. and one by 50-hp., 3,600-r.p.m., G.E. motor. One Moore, 4-stage centrifugal, 90-g.p.m. against 480-lb. driven by Moore 75-hp. steam turbine.

Booster Pumps (2), Make-Up Pump (1): Moore Steam Turbine Co., G.E. motor-driven.

Heating System Pumps: 2, Nash-Jennings, Type E-20, 5-hp., G.E. motors.

Air Compressor (new): One Ingersoll-Rand, twin-cylinder, driven by 125-hp. Westinghouse synchronous-motor at 277-r.p.m., 1190-c.f.m., at 25-lb.

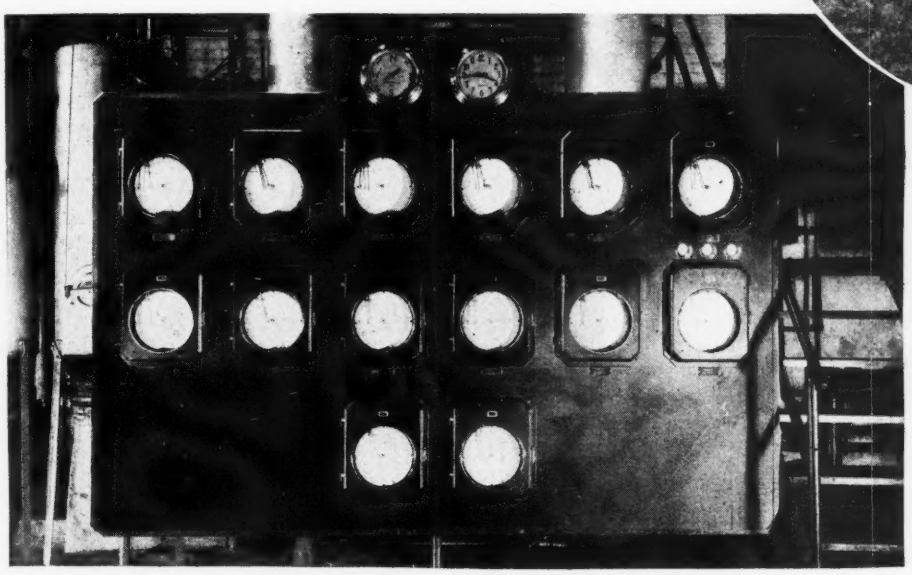
Turbines: Two Moore, 875-hp., 3,600-r.p.m., 10-stage, non-condensing, direct-connected to G.E. 600-kw., 750-kva., 240-volt, 3-phase, 60-cycle generators. Steam rate 21.5-lb. at free exhaust.

Switchboard Equipment: Westinghouse. Designed and erected by Frank Lamberton—Taylor chief electrician.

Process Steam Supply: Boiler steam reduced to 125-lb. by Leslie

INSTRUMENTS GUIDE POWER

IV (Below)—A MODERN SET OF BOILER-ROOM INSTRUMENTS was installed. These include temperature and pressure recorders, multi-pointer draft gages, air-flow steam-flow and recording CO_2 meters. Chemical control for lime-soda-phosphate feed was set up. A new instrument board (Shown in II), with new instruments, was erected in the turbine room.



V (Above)—OPERATING TROUBLES WERE REDUCED. Air-cooled furnace walls, inspected after 16 months operation, were in perfect shape, protected by a heavy layer of slag. Tube scale was eliminated by controlled water treatment. Recording instrumens made it easy to detect leaks from traps, safety valves, blow-off valves and other losses.

Taylor Instrument Companies' Power Plant

reducing valve, and then desuperheated by Elliott desuperheaters, controlled by Taylor recording regulator. Some process steam reduced to 275-lb. (Leslie reducing valve), without desuperheating, for lacquering ovens. Building steam and process at 3-lb. from turbine and auxiliary exhaust augmented by steam reduced from 125-lb. process level.

Instruments: *Bailey Meter Co.*
2 boiler meters, 2 steam-flow meters, 2 feed-water controls.
Hayes Corporation.
1 CO_2 recorder, 2 multi-pointer draft gages.
The American Meter Co.
Process steam-flow recorder.
Taylor Instrument Companies.
8 Index thermometers with electric alarm (4 on turbine bearings and 4 on gen. air cooler) 2 thermostatic controls on generator air cooler water, 22 press. and temp. recording instruments for steam, water, compressed air, etc.

General Information:

PLANT ENGINEER ..... R. A. Taylor
CHIEF ENGINEER ..... W. J. Gessner
CONSULTING ENGINEER (MECHANICAL) ..... J. L. Graham
CONSTRUCTION ..... A. H. Hopeman Co., Rochester
STEEL WORK ..... Leach Steel Corp., Rochester
Genesee Bridge Co., Rochester
COAL-HANDLING EQUIPMENT ..... Link Belt Company
PIPING ..... R. H. Baker Co.
HIGH-PRESSURE VALVES ..... Edward Valve & Mfg. Co.
BOILER MASONRY ..... Wm. Summerhays Corp., Rochester
VACUUM CLEANER ..... Allen & Billmyre Co.
HEAT INSULATION ..... Johns Manville 85% Magnesia
Applied by Smith Murray Corp., Rochester
TILE FLOOR ..... Whitmore, Rauber & Vicinus, Rochester

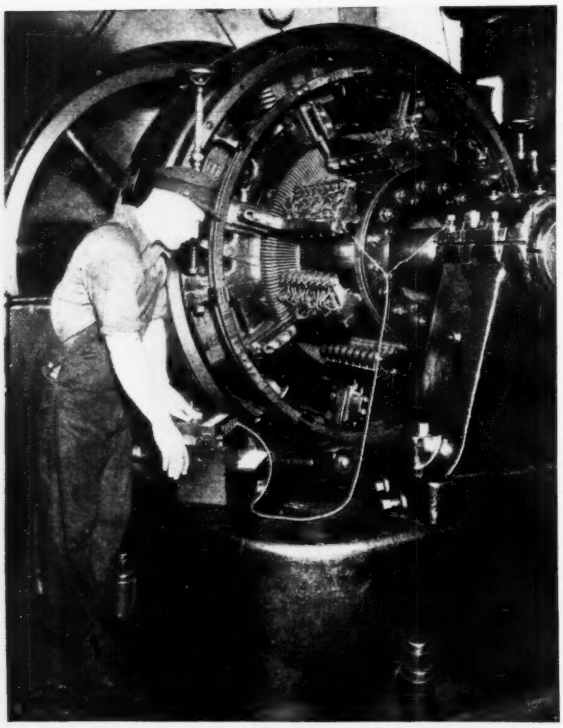
VI (Below)—COAL BURNED FELL OFF 30.5 PER CENT in 1932 in spite of increased demand for heating steam and electricity. This was the combined result of higher boiler efficiency and a lowering of steam rate per kilowatt-hour from 38-lb. for the old Corliss to about 21.5-lb. for turbines (due mainly to higher pressure). Complete records are available in the power-house office of W. J. Gessner, chief engineer.

Kilowatt hours	1930	1932
Generated	726,539	730,700
Purchased	253,400	212,200
Total Generated and Purchased	979,939	992,900
Sold	None	11,980
Used by Taylor	979,939	980,920
Coal		
Kind	Pittsburgh Nut and slack	Lincoln Pulverizer fuel
B. t. u. per lb. as fired	About 14,000	14,800
Tons burned	5,332	3,700
Actual evaporation per lb. coal	About 8.5	About 10.5

METERS and HANDTOOLS

Cut Electrical Maintenance Costs

Improved inspection and maintenance methods, based on the use of proper meters for testing and portable tools for conditioning electrical equipment in place, reduces operating costs



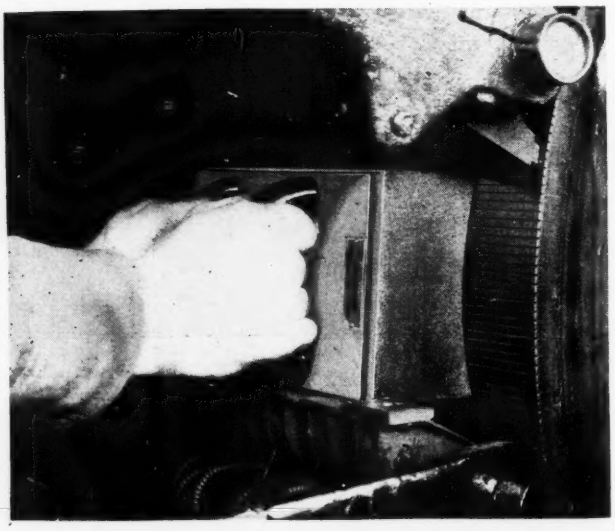
Megohm-meter test being made on insulation resistance

MODERN electrical equipment is so constructed that it may operate for long periods with very little attention. At the same time, however, forces may be at work that, unless they are checked, will eventually cause expensive and unexpected breakdowns. By proper inspection and maintenance methods, such failures can be practically eliminated and most causes of costly repairs corrected before they have done serious damage.

One of the essentials in an adequate inspection and maintenance schedule is a periodic test of load and other conditions under which the equipment operates. For making load tests, recording wattmeters are preferred, for they will give a continuous record of the load over any desired period. These records present an invaluable picture of conditions under which machines operate that cannot be obtained in any other way.

Frequently, these records not only show conditions detrimental to the equipment but also ways of reducing power consumption. It often occurs that loads are materially increased due to factors not readily apparent. Unless these are detected by meter tests, they may continue for long periods and cause large increases in power consumption, and damage to the motors and driven machines.

On alternating-current motors, in addition to checking the power input, a check on the voltage, current and power factor is desirable for complete understanding of the machine's operation. The frequency with which tests are made will depend upon conditions. When setting up a maintenance schedule, all motors should be tested and records made of their load, voltage, current and power factor. These will serve as a basis with which to compare further tests.



Hand stones are a convenient means for truing commutators

After it has been determined that conditions under which a machine operates are fairly stable, tests need only be made at long intervals or when something unusual develops. On the other hand, where motor loads are likely to change, more frequent testing is necessary. In any event testing should be done until those in charge of the equipment are thoroughly familiar with the conditions under which the machine operates.

In electrical equipment the insulation is the most vulnerable part. If insulation breakdowns are prevented a large part of a preventative maintenance job is done. Moisture, oil and dirt are three common enemies of insulation. There are others, such as graphite and acid, but these are associated chiefly with local conditions. Oil, moisture and dirt, on the other hand, are to a greater or less degree present in every installation. A first line of attack to prevent oil, moisture and dirt from getting into

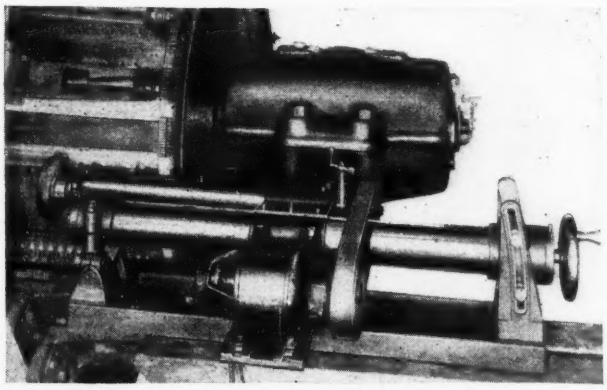
windings of rotating machines is to keep the oil in the bearings and if necessary to provide proper protection to keep moisture from getting on the windings. The application of anti-friction and improved types of sleeve bearings has gone a long way toward preventing oil from getting on windings.

When electrical machines have been protected as much as possible by visible means and are kept clean, there are still unseen conditions that may be weakening the insulation. These can only be detected by testing. Although an insulation resistance test does not tell all that might be desired about a winding's condition, for general maintenance purposes it is the most satisfactory.

Insulation resistance may be measured in several ways, but megohm meters are probably the most widely used. Several types are available. They are portable, easily applied and are direct reading. By periodically making megohm-meter tests on the insulation and keeping a record of them, dangerous weakening of insulation can be detected before failure occurs. Insulation resistance tests should also be made on the control equipment and feeder circuits.

By a careful check of insulation resistance in one large plant, where the electrical equipment operated under moisture conditions, short circuits were practically eliminated. Before the present system of insulation testing was adopted in that plant, circuit and motor failures were of common occurrence. Not only did improved maintenance eliminate electrical troubles, but it also materially reduced the cost of this work.

Insulation on machine windings tends to dry out and crack, due to high temperatures and bending actions produced by magnetic stresses and other causes. These



A power-driven grinding wheel for truing commutators

cracks provide lodging places for dirt and moisture that cause leaks through the insulation, and if not corrected result in failures. These can be prevented by periodically cleaning and drying the windings and giving them a coat of insulating varnish. Where machines cannot be taken to a shop for treatment, the work may be done on them in place and the varnish sprayed on by devices that can be taken to the job. The period between these treatments will vary from six months to three years, depending upon operating conditions.

For cleaning the machines, compressed air and vacuum devices have come into wide use. Vacuum cleaning is preferable, as it removes the dirt entirely and does not blow it from one place to another as does compressed air. Portable blowers and vacuum cleaners are available that may be easily handled by one man.

Commutators and slip rings are vulnerable spots in electrical machines and require varying amounts of attention depending upon several factors. Undercutting eliminates high mica on commutator surfaces, a common source of trouble with flush mica. To do this work, hand tools have been developed which vary from a simple hand cutter to power-driven machines, any of which may be applied to the machine in place.

When mica is undercut, care must be exercised to keep the slots clean or short circuits may develop between the commutator bars. If conditions are such that it is difficult to keep the slots clean, they may be filled with an insulating cement.

A good surface must be maintained on commutators and slip rings if satisfactory operation is to be obtained. For doing this there has been developed a wide variety of portable tools. These vary from simple hand stones to power-driven grinders. For periodically dressing up commutators or slip rings, hand stones serve the purpose very nicely. If the surfaces are in bad shape, then stones mounted on a lathe rest or a power-driven grinding wheel should be used. Lathe tools are also used for this purpose, but the stone gives the best surface.

The amount of attention commutators and slip rings require is about the most variable factor in their operation. Some operate for years and require no more attention than a periodic wiping with a piece of canvas and a cleaning out of the slots, while others need almost daily attention.

Even though protection equipment may not be a maintenance tool, it certainly has a place in every adequate preventative maintenance program. Unless electric power equipment is properly protected, no amount of inspection and testing will prevent serious failures. The amount and kind of protection required depends upon conditions. In clean surroundings, the chief consideration is to protect against overloads. In severe applications, mechanical protection may be of equal importance. The conditions under which equipment operates should be carefully studied and protection provided that conforms to safe practice.

Power-driven tool for under-cutting mica between commutator bars

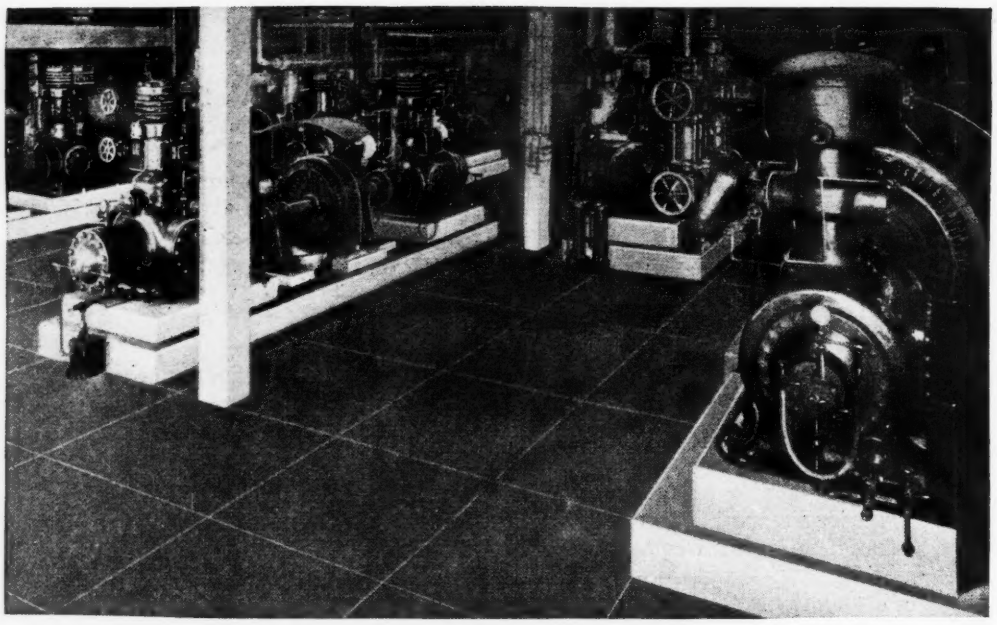


Fig. 1—This plant produces solid CO_2 from burning methane

How to Make Solid CO_2 from Flue Gas

By W. R. KITZMILLER

CARBON dioxide for making solid CO_2 has generally been obtained as a byproduct from the manufacture of alcohol, natural CO_2 gas wells, chemical reactions, lime kilns, and cement plants. The purest gas has been obtained from the first source. CO_2 from natural wells, about next in purity, usually contains one or two other gases difficult to eliminate. In addition, these wells are generally far from a market, which complicates handling.

Return of the brewery provides another soure of CO_2. The quantity available depends on the process employed, but generally runs in the neighborhood of 9 lb. of gas per barrel of beer.

Recovery of CO_2 from flue gas requires an absorption system to separate it from other gases present after combustion. The final compression system, however, does not differ from that required for a relatively pure CO_2, obtained from other sources.

Absorption Systems

Fig. 2 illustrates the cycle for recovering CO_2 from flue gas. The gas first passes through an economizer where it gives up heat to a strong lye solution. After leaving the economizer at approximately 300 deg. F., the flue gas passes on to scrubbers where water removes entrained dust and sulphur. In the scrubbers, the gas is not only partially purified, but also reduced in temperature, leaving at about 140 deg. F.

A blower picks up the gas from the scrubbers and sends it on through absorption towers. Here it comes in contact with the lye solution, which absorbs the CO_2. The towers are generally 10 ft. in diameter and 100 ft. high. Coke is placed on grids at intervals throughout their height. The lye solution is sprayed in at the top of the tower and drains into the strong lye tank. Waste gas is discharged to atmosphere through a vent on top of the second scrubber.

The lye solution absorbs only the CO_2, and that containing a high percentage of the gas is called the "strong" lye solution. Weak lye at about 125 deg. F. is sprayed into the second absorber, and strong lye is circulated through the first. This arrangement permits the greatest recovery of CO_2.

Strong lye is pumped from a storage tank through a heat exchanger, which it enters at approximately 140 deg. There it receives heat from the weak lye solution, its temperature being raised to approximately 200 deg., while the weak lye solution is cooled to 160 deg., from an entering temperature of about 245 deg. From the heat exchanger the strong lye solution passes through the economizer, finally entering the lye boiler at 225 deg. F.

Exchange of heat effected in this cycle is of primary importance for economical operation. The principle involved is the reduction of the temperature of the weak lye solution in its course to the absorber, and the heating of the strong lye on its way to the lye boiler. The temperature of the weak lye is further reduced by a water cooler before it is sprayed into the second absorber.

In the boiler the strong lye solution is heated to about 250 deg., which drives off the CO_2 gas. It then passes to a cooler, where its temperature is reduced to about 90 deg., after which it is generally stored in a gasometer.

Compression System

Fig. 3 is a diagram of a cycle used in making solid CO_2. The gas is compressed in three successive stages up to the condensing pressure necessary to liquefy the CO_2 at the temperature of the available water. General practice is to obtain water at a temperature of 70 deg. or lower, if possible.

Removal of oil is important, since the least trace will make the product difficult to sell. This is accomplished by passing the compressed gas through water-cooled oil separators and filters.

Liquid CO_2 from the condensers is collected in a receiver, which should have ample capacity. A pressure reducing valve in the liquid line reduces the normally high liquid pressure to 600 or 700 lb., thus eliminating some of the usual losses in gas, and requiring less attention to the setting of expansion valves on the liquid coolers. Liquid cooling gas returns to the suction of the second- and third-stage compressors, where it mixes with the gas discharged from the two previous stages. Depending on the cooling water temperature, gas is discharged from the two stages at approximately 95 deg., after leaving the intercoolers. Part of the coldest water is often run through these coolers on the way to the condenser.

Stage pressures of the compression system depend on the machine ratios employed, but generally run 5-lb. suction to the first stage, 70- to 90-lb. pressure discharge, which is the suction to the second stage. The discharge pressure of the second stage varies between 300 and 350 lb., which is also the suction pressure on the third-stage compressor. The discharge pressure of the third

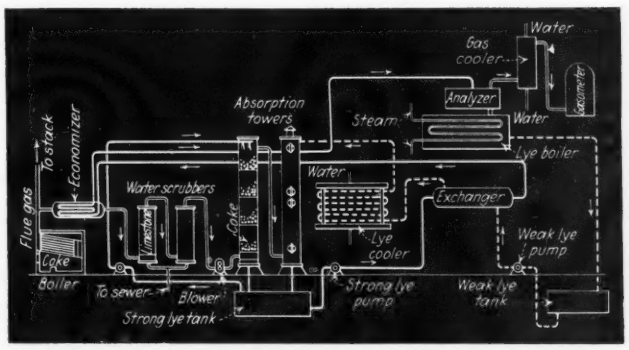


Fig. 2—CO_2 is recovered from flue gas by an absorption system

stage depends on the water temperature, as previously explained.

It is considered economical practice to employ a blower between the gasometer and the first-stage compressor. In this manner a large volume of gas can be raised to 5-lb. pressure with less horsepower than that required in the first stage of compression.

Mixers are used to reduce the velocity of the cold and warm gases and to obtain as close to a saturated gas mixture as possible. A slight excessive feed to the liquid coolers will provide liquid CO_2 for cooling the compressed gas. The object of cooling the CO_2 liquid so low is to obtain a high conversion of liquid to snow in the snow machine. This conversion averages around 50 per cent with —30 deg. F. liquid. The heat exchanger between the last stage of liquid cooling and the snow machine is sometimes employed to remove further heat from the liquid with the cold blow-back gas from the snow machine.

CO_2 liquid is expanded into the snowing chamber of the snow machine at about 60 lb. gage pressure. The temperature at this pressure is —70 deg. F. and is called the triple point because a gas, liquid or solid can exist under this pressure and temperature. As soon as the chamber has filled with snow, the pressure is allowed to fall to approximately 5 lb. gage, and the snow is compressed to a solid block. Gas liberated in the snow machine and called "blow-back gas," is taken into the first-stage compressor along with the "make-up gas" from the gasometer.

Solid CO_2 is compressed in the snow machine to 10-in. cubes, weighing from 40 to 50 lb., depending on the density desired. The quantity of solid CO_2 produced depends on the temperature of the liquid to the snow machine and theoretically follows the table below:

Temp. of liquid, deg. F.	Per cent solid CO_2	Per cent Blow-back gas to first stage
+10	44	56
0	46	54
—10	48.5	41.5
—20	50.5	49.5
—30	52	48

Several modifications of the compressor system permit flexibility and other uses. Compressors can be so arranged that the proper stage ratios are available for manufacturing liquid CO_2. Therefore, liquid CO_2 could be produced at times and stored or bottled for direct sales or to be converted later into solid CO_2. Compressors could be arranged to produce solid CO_2 from liquid at a later time.

Storing of CO_2 gas in gasometers during peak demand on power generating equipment may be economical, since there is more power available during the off-peak period to operate the solid CO_2 plant. This will be governed a great deal by investment cost, since gasometers and space for them may be expensive. Selection of drives is of great importance, so that off-peak reserve can be worked into the full production of solid CO_2 without overload.

Cheaper fuel may be possible when CO_2 gas or liquid is stored. It may also be possible to produce part of the power load on cheap fuel and use coke for CO_2 production only. These considerations depend to a great extent on operating costs and cannot be treated alone on engineering merit. It must be remembered in selecting fuel that only about 3 lb. of CO_2 are actually recovered from each pound of carbon burned. The reason for not obtain-

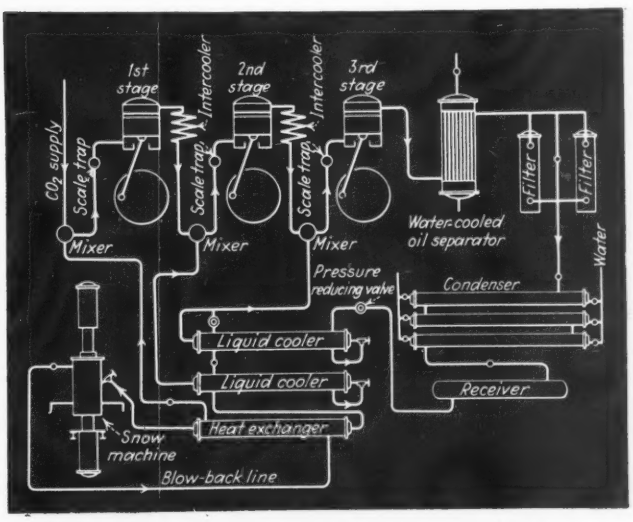


Fig. 3—Diagram of cycle for making solid CO_2

ing the theoretical value of 3.8 is the inefficiency of the absorbing system and imperfect combustion. Fuel known as 72-hour coke contains as high as 97 per cent carbon and naturally represents one of the best forms of carbon for generating CO_2 gas.

It has been found that under some modern operating conditions, 2 lb. of CO_2 have been produced per pound of coke, but as a general rule the ratio has been nearer one to one. Ideal firing conditions are required to keep the CO_2 content high, as perfect combustion of oxygen and carbon naturally produces a greater quantity of CO_2. Perfect combustion and absorbing are impossible, so some CO_2 is lost through the vent of the second absorber along with a large quantity of nitrogen and smaller quantities of oxygen, carbon monoxide, sulphur dioxide and hydrocarbon gases.

Power required to produce solid CO_2 averages about 420 hp. per ton hour. Use of the split-stage system as outlined in *Power*, Jan. 19, 1932, would reduce power requirements, especially if high-temperature water must be used. Regardless of equipment or system, there are three important requirements of CO_2 gas going to the snow-producing machinery. It must be reasonably free of moisture, odor and oil. Elimination of oil was mentioned before and is also covered in the issue of *Power* referred to.

Moisture and odor in the CO_2 have been successfully eliminated with several different types of equipment. Activated carbon filters, chemical processes, silica gel and alumina gel have been applied to the purifying process, while the last two have also been applied to the drying process. Activated carbon also acts as a partial drier in the purifying cycle.

Solid CO_2 at atmospheric pressure (in comparison with ice) will absorb nearly twice the heat of melting ice at 32 deg. F. and approximately three times the heat of ice and salt around 0 deg. No moisture is released by the melting of solid CO_2 and there is naturally no corrosion. This makes it ideal for shipping cold-storage products.

INDUSTRIAL POWER GETS A "NEW DEAL"

● Two inevitable outcomes of the "new deal" in American industry will be improved position of the small manufacturing unit and greater executive attention to problems of industrial power. These points were stressed by E. C. Hutchinson, president of the Edge Moor Iron Company, in a talk before the Philadelphia Engineers Club on April 11.

Said Mr. Hutchinson:

"Now obviously power is going to enter more and more into the consciousness of industrialists. The reasons for this are simple:

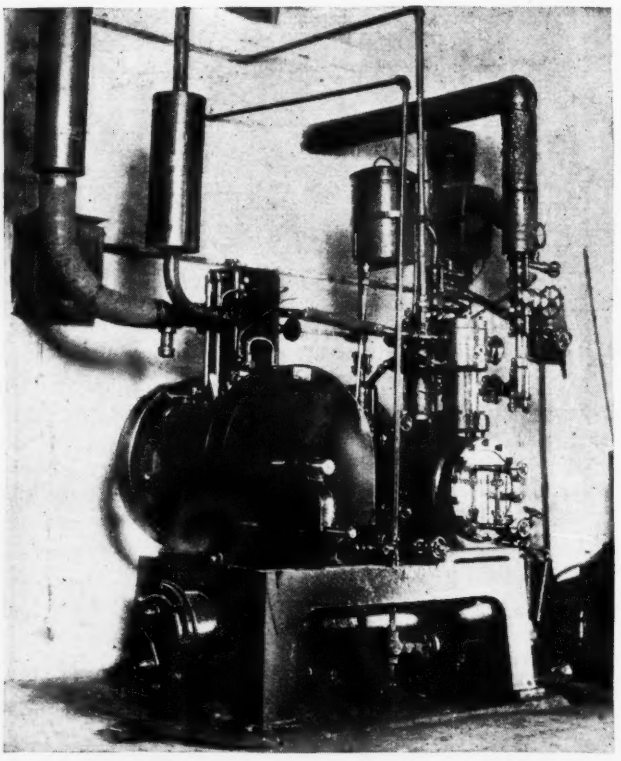
"1. Never before has the demand for lowering the cost of manufactured products been so great as at present.

"2. Older companies, being forced to meet the competition in their products arising from businesses born as offshoots of their own, but without the larger overhead and capital costs, are now paying attention to their cost of power production and are giving thought to the comparative economies of purchased or made power as never before. Combinations of process-heat generation, air conditioning and by-product power are getting more attention.

"3. The newer and smaller companies have sprung into existence at a time when economy is recognized as the very foundation stone of industrial existence. The idea of watching and guarding against all possible leaks in expense has also given them a view of the economies possible in the power plant which, in many cases, some of the established companies are only just now commencing to realize.

"4. General business conditions have, in a great many instances, forced even the best and most important of the public utilities to reduce personnel. What should be more natural than that expert power engineers, having received their training in the best public utilities, should capitalize their knowledge by entering into the design and construction of small power plants for isolated operation? The result has been that now the smaller industrial plants possess as effective operating power and heat units as many of the larger ones. Manufacturers have put out designs and equipment which will accomplish in the smaller-sized installations a degree of operating perfection and simplicity in every way comparable with that of the larger installations."

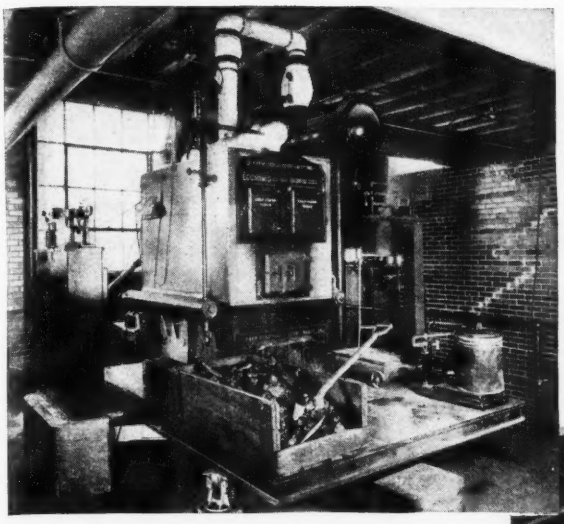
SMALLEST DIESEL-COMPRESSOR SET



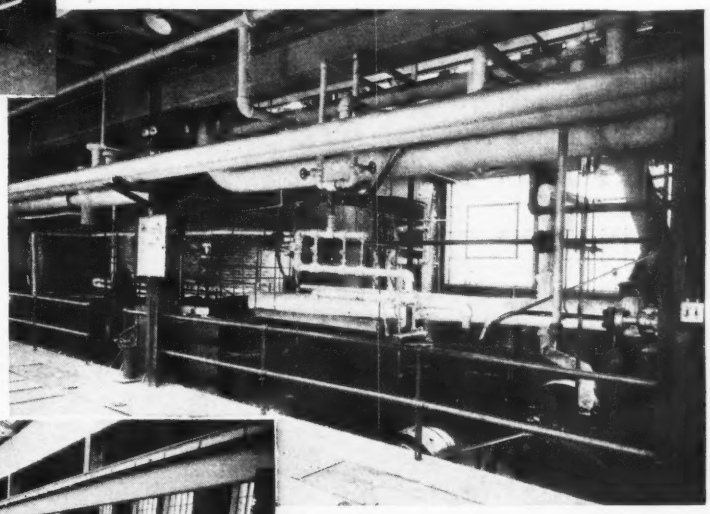
This installation in the store of Tampa (Fla.) Grocery Co. is composed of a 5-hp. Lister engine driving a small compressor. The day tank at center holds enough fuel for 40 hr. operation, the diesel uses compressor waste for jacket water, and the installation will pay for itself in less than two years in savings over purchased power.

MORE POWER RESEARCH FOR "BOILERMAKERS"

Newly dedicated Mechanical Engineering Building at Purdue University includes 3-story steam-engine laboratory



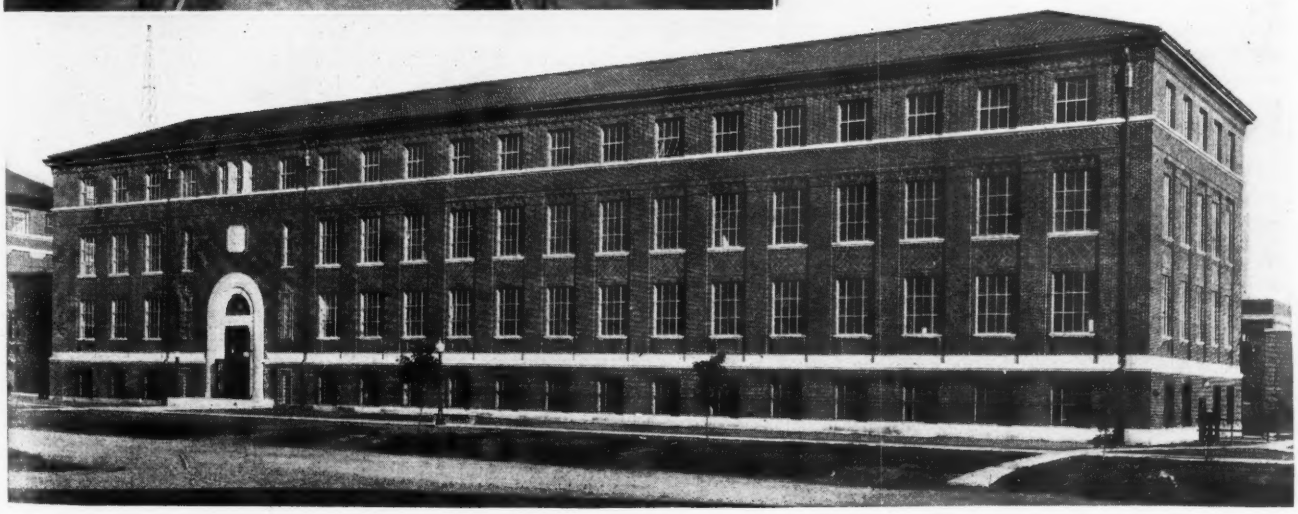
Above—Boiler and all equipment on scales to test efficiency of domestic stokers, probably only installation of its kind in existence



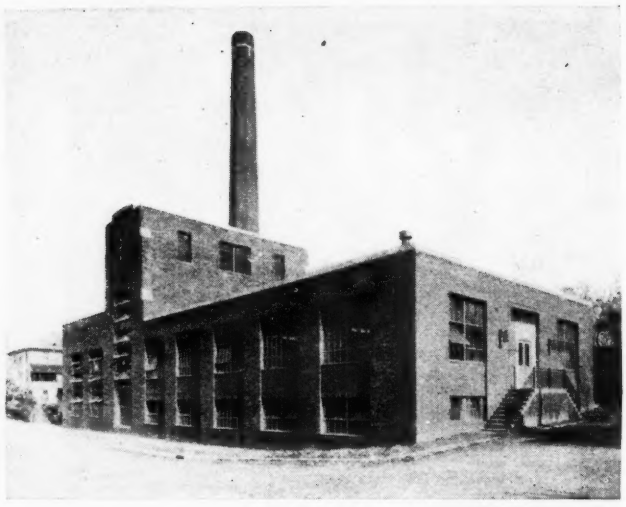
Right — The Purdue high-pressure boiler, showing feed-water pump, heat exchanger and thermocouple temperature switchboard. Pressures up to 4,000 lb. are being tried

Left—General view of the steam laboratory, showing constant temperature room at extreme left and steam engines, turbines, instruments and similar equipment ranging the galleries. A 10-ton crane serves all three levels. More than 800 students receive instruction there

Below — Lecture rooms, class rooms, drafting rooms and automotive laboratory are housed in the 4-story, 230x63-ft. building itself. The steam engine laboratory extends from its rear center



STEAM, POWER and HOT WATER for The Hill School



By R. S. FITCH
Mechanical Engineer, The Ballinger Company

ON AN eminence in the Schuylkill Valley at Pottstown, Pa., is The Hill Preparatory School for Boys, where facilities are maintained for 460 resident students, 40 staff members and 100 employees. In the past few years the school had expanded its educational facilities until the 30-year old boiler plant became inadequate and obsolete.

In the old boiler plant, four 1,500-sq. ft. H.R.T. boilers operating at 100-lb. pressure supplied steam demands. One 75-kw., 125/250-volt and one 50-kw., 125-volt D.C. engine-driven generator and a belt-driven 30-kw., 220-volt, 3-phase generator supplied power and light requirements, augmented by an additional 15-kw. a.c. load from the power company.

Although only a new boiler plant was necessary to supply steam demand, the school authorities decided to investigate the possibility of generating all current. In 1931 a survey was made to determine the most economical installation, and as a result, a new boiler and generating plant has just been installed. A new laundry was included as part of the power house building, with complete laundry and tailoring service for students and staff members. Savings of the new plant compared to the old have been estimated at 20 per cent.

The school operates from the middle of September to the middle of June. During this time all steam and power requirements are generated by the plant. In the summer the plant is practically shut down, maintaining sufficient steam pressure for some hot water and fire protection. Light and power requirements are supplied by the local power company to the extent of 30 kw. This service provides for emergency lighting and all essential motor applications.

Steam is generated by two 3,610-sq. ft. boilers, with one normally on the line at 125-lb. gage, and fired with stokers burning Pennsylvania bituminous run-of-mine coal. Space is provided for a third unit to permit expansion. Current for light and power is produced by two uniflow-engine-driven generators, one 150-kw. and one 250-kw., 208-volt, 3-phase, 4-wire units operating with a back pressure of 1 to 2 lb. gage. This pressure is carried on the heating system, the feed-water heater and the hot-water generators.

Estimated average loads on the plant with 100 per cent matriculation were:

Steam	Lbs. per hour — Present	Future	Electrical	Kilowatts — Present	Future
Heating	10,000		Day	75	150
Water Heating	3,700		Evening	80	170
Laundry	640		Night	40	75
Cooking	1,120				
Sterilizers	320				
	15,780 lb.	27,000 lb.			

Actual operation for the months of January and February, 1933, with 80 per cent matriculation, was:

	Lb. Steam per hour	Kilowatts
7 A.M. to 3 P.M.	14,000	68
3 P.M. to 11 P.M.	13,000	80
11 P.M. to 7 A.M.	12,000	47

The present maximum load on the plant is about 20,000 lb. steam per hour and 100 kw. Feedwater is delivered to the boilers at an average temperature of 214 deg. With coal at 14,000 B.t.u., the average operating efficiency is 72 per cent.

Coal is delivered to a 200-ton overhead coal storage bunker by an elevator and conveying coal-handling system. Spouts deliver the coal by gravity to the stokers with provision for weighing. Ashes are removed by a steam ash conveyor, discharging to an elevated ash storage tanks from which ashes are discharged to trucks.

One of the problems of design was the distribution of power services. The old boiler plant was located at the highest point of the school property, while the new plant is at the lowest. The old distribution was in direct counterflow to the new arrangement, and new tunnels were constructed and old tunnels enlarged to provide for the change. Light and power distribution was changed from d.c. to a.c.

The engines exhaust to the low-pressure heating main distributing throughout the campus, and a booster pressure-reducing valve from the high-pressure system in the boiler plant provides for the heating of the gymnasium. The continuing low-pressure line leaving the gymnasium is also provided with a booster pressure-reducing valve and supplies the remaining buildings. Vacuum pumps maintain a 10-in. vacuum on heating system returns. The dwellings at the extreme edges of the campus are heated with high-pressure steam.

Water is obtained from the local water company and is filtered and softened. Hot and cold water is supplied to each student's room; hot water for students and that for the gymnasium constitutes a large part of the hot

Principal Equipment, Power Plant

THE HILL SCHOOL, POTTSTOWN, PA.

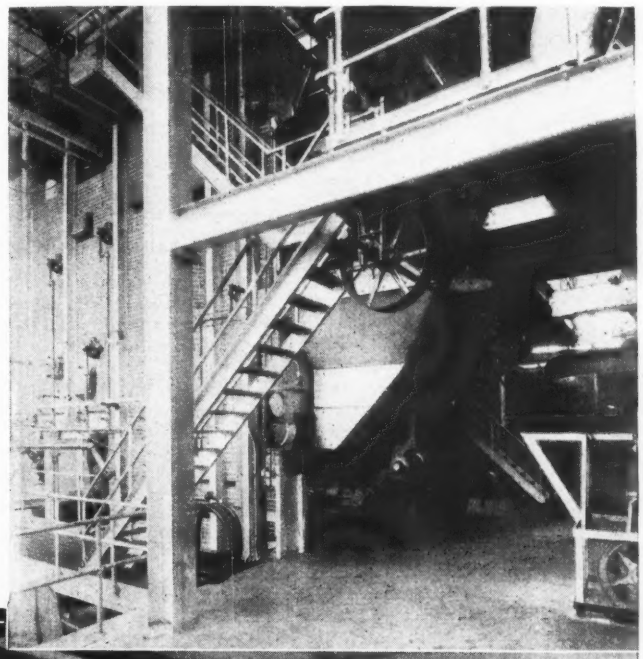
Boilers—Two Edge Moor, 4-pass., water-tube, 3,610-sq.ft. Designed for 150-lb. pressure; operating at 125-lb. gage, no superheat	Edge Moor Iron Co.
Blow-off Valves—Yarway Tandem	Yarnall-Waring Co.
Soot Blowers	Vulcan Soot Blower Co.
Boiler Settings—solid brick	Ballard Sprague & Co.
Stokers—Two Taylor, 17-tuyere, 4-retort, 651-sq.ft. area, power dump, 300% capacity	American Engineering Co.
Driven by 7.5-hp. motors	Crocker-Wheeler Elec. Mfg. Co.
Forced Draft—One No. 2½, Type FD, fan	Clarage Fan Co.
Direct-connected to 40-hp., 3-speed motor	Crocker-Wheeler Elec. Mfg. Co.
Engine Generators—One 19½x20-in. horizontal poppet valve uniflow	Ames Pump Co.
Direct-connected to 187-kva. (150 kw.@0.8 P.F.) 208/120-volt, 3-phase, 60-cycle, generator, direct-connected exciter, 222-hp. @ 200 r.p.m.	Crocker-Wheeler Elec. Mfg. Co.
One 19x26-in. horizontal 4-valve uniflow	Kingsford Fdy. & Mach. Co.
Direct-connected to a 312-kva. (250 kw.@O.8 P.F.) 208/120-volt, 3-phase, 60-cycle, direct-connected exciter, 200 r.p.m.	Crocker-Wheeler
Switchboard	Westinghouse
Motor Drives	Crocker-Wheeler
Feedwater Heater—One 800-hp. metering dearating type, 30,000-lb. per hr.	Cochrane Corp.
House Pump—Two centrifugal (cold water supply) 250 g.p.m., 25-lb. suction pressure, 90-lb. discharge pressure	Kingsford Fdy. & Mach. Co.
Hot-Water Circulating Pumps—Two 59-g.p.m. centrifugal, 40-lb. suction, 90-100-lb. discharge pressure	Kingsford Foundry & Machine Co.
Hot-Water Generators—Laundry, one 60x168-in., 1,500 g.p.h.@1 lb., 2,000 gal. storage. Plant, one 72x174-in., 2,000 g.p.h.@1 lb., 3,000 gal. storage.	Whitlock Coil Pipe Co.
Sump Pump—One 250-g.p.m., 30-ft. head	Kingsford Foundry & Machine Co.
Vacuum Pump—One motor-driven unit for 60,000-sq.ft. radiation, 20-lb. discharge	Nash Engineering Co.
Two 8x10x12-in. units, American-Marsh	American Steam Pump Co.
Boiler Feed Pump—One 6x4x8-in.	Union Steam Pump Co.
One 8x5x12-in	American Steam Pump Co.
One 12x18x8x12in. compound, steam-driven	Union Steam Pump Co.
Air Compressor—One 4x4-in.	Ingersoll-Rand Co.
Water Softeners—Two zeolite units	Permutit Co.
Water Filters—Four sand filters	Loomis-Manning Filter Distributing Co.
Coal Elevator Conveyor	Latimer & Co.
Ash-Handling—Steam-jet ash conveyor	Frederick Engineering Co.
Stack—141½ ft. high, 6½ ft. diameter	Rust Engineering Co.
Smoke Breeching	Connery & Co.
CO_2 & Stack Temperature Meters	Leeds & Northrup Co.
Draft Gages, Triple-Dial differential	Hayes Corp.
Piping	L. J. Sommer & Son
Electrical	Berks Engineering Co.
Architectural & Engineering Plans & Specifications	The Ballinger Co.

water requirements. The system of water supply is arranged with two 250-g.p.m. pumps maintaining 90-lb. pressure, avoiding the necessity of a costly 100,000-gal. water tank and distribution system.

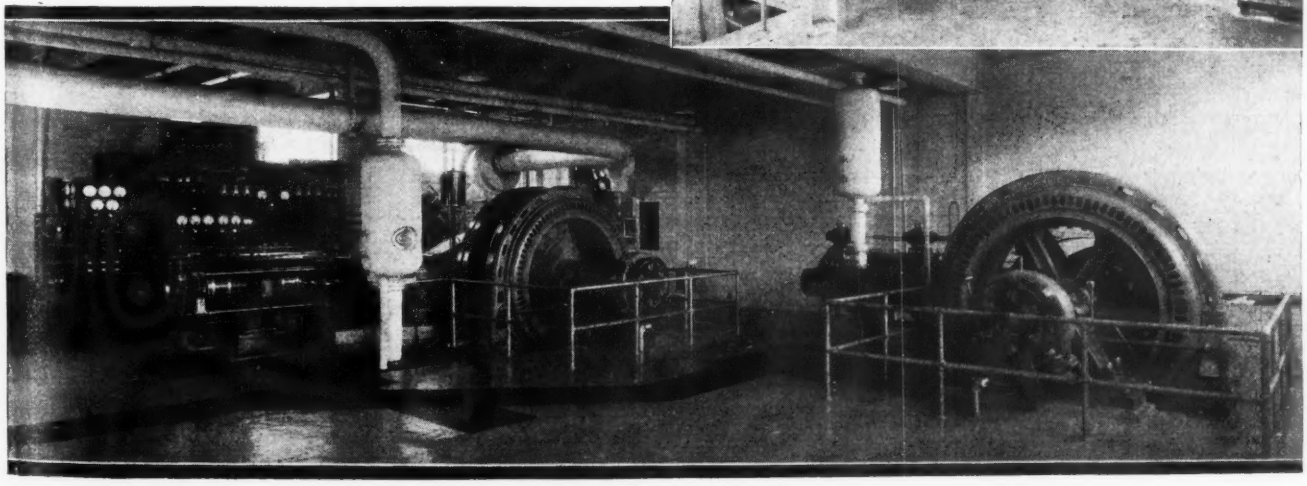
The hot water system operates at 90-lb. pressure with positive circulation from two 50-g.p.m. pumps on the hot-water return line, one pump operating normally. Buildings close to the power plant are supplied with hot water through pipes in the tunnel, while outlying buildings are supplied by piping buried in concrete and wooden ducts covered with mineral wool.

The new boiler house and laundry building is 60 ft. wide and 134 ft. long and is one and two stories high. The one-story section is occupied by the boiler room, and the engine and machine rooms are on the ground floor of the two-story building, with the laundry on the second story. To avoid any possibility of fumes from the power house chimney becoming objectionable to the school or the surrounding community, chimney height has been made 141 ft., with inside diameter 78 in. Naturally, the chimney is prominent, and considerable thought was given to obtaining an attractive architectural design. Accordingly, an octagonal shaft with architectural brick and limestone ornament is provided.

The plant survey analysis and design were made by engineers of the Ballinger ompany. The steam-driven vacuum pumps and the water filters are from the old plant. Standby apparatus is supplied wherever necessary.



The engine room is beneath the laundry in the 2-story portion



Two 3,610 sq.ft. boilers are installed and space has been left for a third

AUTOMATIC DEVICES MAKE CENTRIFUGAL PUMPS

Separate vacuum-producing equipment for priming centrifugal pumps was discussed in *Power* in April. In this second article, devices are described that may be attached to centrifugal pumps to make them self-priming

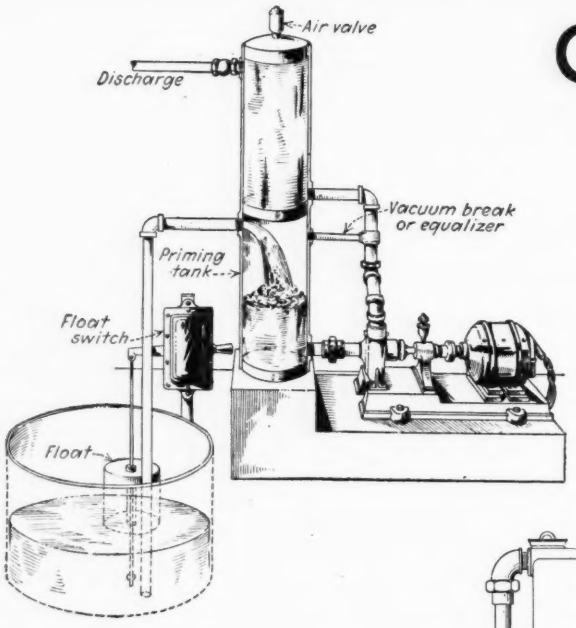


Fig. 1—Automatic priming system using a divided priming tank

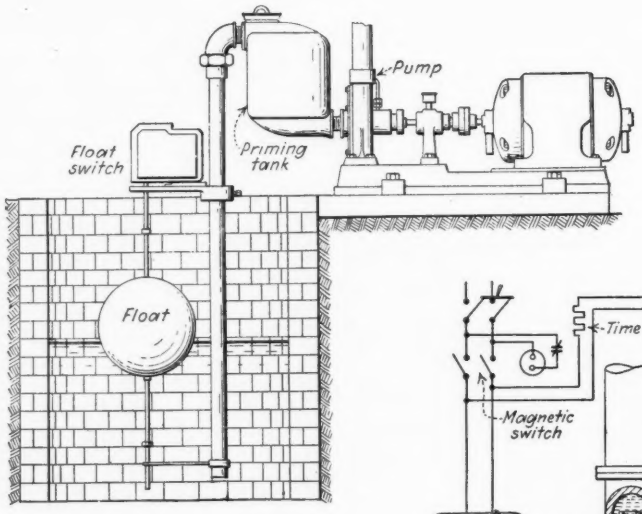
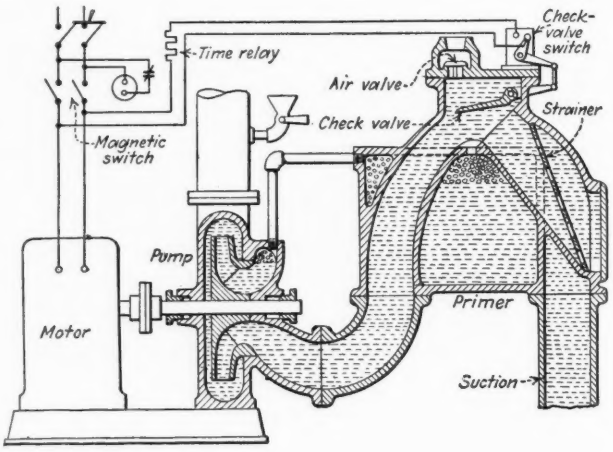


Fig. 2—Automatic priming system using a single priming tank

Fig. 3 — Automatic priming system operating on the principle of a wet-vacuum pump



THERE are three general methods of making centrifugal pumps self-priming: The first is to connect a comparatively large chamber to the suction of the pump. When the pump is stopped this chamber is kept full of water. On starting, the pump discharges water from the priming chamber, but before the priming chamber is emptied a sufficient vacuum is produced to cause water to flow into this chamber and maintain a supply at the pump suction. The second method is to keep the pump full of water when it is stopped. When the pump is started, this water is recirculated through the pump to convert it temporarily into a wet vacuum pump to exhaust the air from the suction line. The third method is to use a small automatically controlled vacuum pump to keep the centrifugal pump primed.

Fig. 1, an example of the first method, is an Automatic Primer Co. system. The priming tank is divided by a horizontal partition, with the pump suction connecting to the bottom of the lower half and the discharge to the bottom of the upper half. When the pump is first started, the air valve is removed from the top of the tank and water poured in to fill the bottom half of the tank and the pump up to the suction connection. When the pump is started, it transfers water from the bottom half to the top of the tank. As the water lowers in the bottom half, it reduces air pressure in the suction line until water begins to flow into the tank and the pump goes into regular operation.

When the pump stops, water flows by gravity into the pump and the lower half of the tank, air entering through the valve at the top of the tank. This back flow of water forces the air out of the lower half of the tank and leaves it and the pump casing full of liquid ready for the next operation.

A small pipe connected between the discharge pipe and the priming tank acts as a vacuum breaker and insures that the priming tank and pump remain full of water. The air valve at the top of the tank will pass air in or out of the tank but will not allow water to flow out. The latter operation is taken care of by a float operated valve.

The suction lift for which this system can be used depends upon length and size of suction pipe and size of

SELF-PRIMING

priming tank. Suction pipes more than 70 ft. long and suction lifts of more than 20 ft. are not generally recommended.

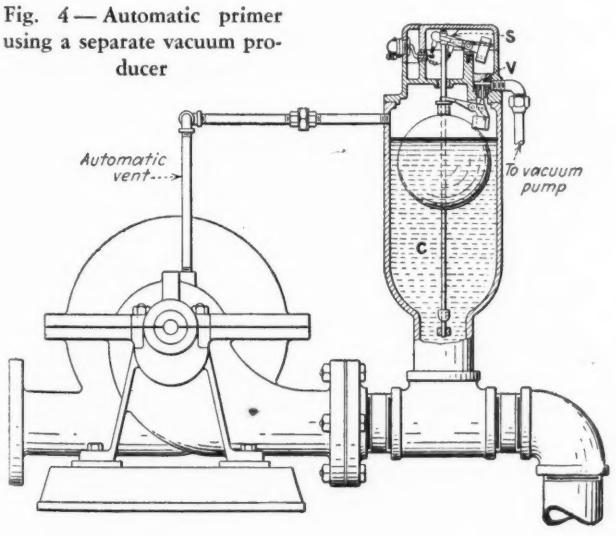
The Goulds Pumps equipment in Feg. 2 is for priming small pumps operating under low heads. A simple priming tank is connected to the pump suction and is filled with water when the pump is first started. On starting the pump, water is drawn from priming tank. Before this tank is empty a vacuum has been produced in the suction line to lift water into the priming tank. When the pump is stopped, water may leak from the suction line but the tank will remain full to prime the pump when it again starts. This equipment is recommended for suction lifts up to 5 ft. and with suction pipes up to $1\frac{1}{2}$-in. diameter, 10 ft. long.

A cross-section through a Barrett Haentjens suction-line primer is shown in Fig 3. This primer may be attached to any centrifugal pump, and combines a strainer, check valve and means of exhausting air from the suction line. During priming the pump is started and stopped repeatedly by a timing relay.

For initial prime, pump and priming chamber must be filled with water through a connection in the discharge line. The pump is then started by closing the line switch, or the connections may be made to operate from a float switch. When the pump is started, it runs only long enough to empty the priming chamber, then is stopped by the timing relay. Pumping water out of the priming chamber allows it to fill with air from the suction line. This air is trapped in the suction chamber by the check valve. When the pump stops, the water runs back into the priming chamber and forces the air out through the air valve.

While the suction chamber is refilling the timing relay resets and the pump is again started and removes more air from the suction line. Starting and stopping is repeated at regular intervals until the pump is primed and begins regular operation. When this occurs, the flow of water to the pump holds the check valve and the check-valve switch open, the latter de-energizing the timing relay. Should the pump, during operation, lose its prime, the check valve and check-valve switch close, bringing the timing relay into operation automatically until the pump is primed.

Fig. 4 — Automatic primer using a separate vacuum producer



This suction line primer is really a wet-vacuum pump. The check valve is the suction valve, the air valve the discharge valve and the rising and falling body of water the piston, the centrifugal pump actuating the piston.

The check-valve is on the suction side of the pump, so that the pump is under pressure when shut down, thus preventing air leaking through the stuffing boxes into the pump or suction line. Once primed the pump and suction line remains primed for a long time when the pump is shut down.

Fig. 4 is a Skidmore Corporation arrangement for automatically priming a pump and keeping it primed. This equipment can be attached to any pump. The float chamber C is attached to the suction of the pump. In the top of the float chamber is a float-controlled switch S for starting and stopping the separately driven vacuum pump for priming the centrifugal pump. A vacuum check valve V is also controlled by the float.

When the pump is not primed, the float is at the bottom of the chamber, the switch S is closed to start the vacuum pump and valve V is open to connect the float chamber to the vacuum producer. As the vacuum pump exhausts air from the float chamber water rises to the intake of the pump and into the float chamber. When the float has been raised to the position in the figure the switch is tilted to stop the vacuum pump and valve V is closed to seal chamber C from the vacuum device.

As long as vacuum is maintained in the float chamber, the float will remain in a position to hold switch S open. If the vacuum fails for any reason the liquid level falls in the float chamber until the float starts the vacuum-producer and restores the water level. This keeps the pump primed at all times. The equalizing pipe, connecting the top of the float chamber to the centrifugal-pump casing surrounding the eye of the impeller, permits the water to rise to a high level, thus priming the pump.

The vacuum producer may be connected to a battery of pumps to keep them primed. In that case, all float-chamber switches are connected in parallel and vacuum-sealing valve connections are also connected together and to the vacuum pump. When all the pumps are primed, the vacuum producer is shut down. Should the vacuum in any float chamber decrease until a float closes its switch, the vacuum pump will be started and the water level restored in the float chamber. This system may also be applied to a steam, air- or water-operated ejector for priming pumps and keeping them primed.

● PORTABLE POWER PLANTS may solve the problem of building utility electrical load in isolated territory, according to A. H. Heitzler, Public Service Company of Colorado. "If there is anything in the generation of power with oil engines—and I think there is—the power companies should be the ones to use this equipment," he said recently. "As our facilities are developed into far-flung regions, oil engine equipment on railroad cars can pick up loads and carry them until economic conditions allow extending of transmission lines. Then the oil engine can be moved farther into the district."

Rate and Quantity Records
TRANSMITTED OVER TELEPHONE CIRCUITS

By CHARLES G. RICHARDSON
Builders Iron Foundry

By this system of long-distance metering records of flow, pressure, position, temperature and other quantities can be transmitted long distances over circuits used for telephone service

TO MAKE possible transmission of plant-performance records and other operations any distance, systems of telemetering have been developed. Telemetering may be considered as the remote indicating, recording and integrating of quantities by electrical means. Normally, electrical and mechanical quantities are involved, such as volts, amperes, watts, pressure, position, liquid levels, flow rates, temperature, and other values.

Because of developments in the water, oil, and gas industries, particularly in transportation of these fluids by long pipe lines, the necessity for telemetering of mechanical quantities promises to come into prominence comparable with its importance in the electrical field, as an aid to more economical and satisfactory operation. Those interested in telemetering problems are referred to the report on telemetering, supervisory control and associated communication circuits, presented at the 1932 summer convention of the American Institute of Electrical Engineers by a subcommittee of the committees on Automatic Stations and on Instruments and Measurements.

A new system of telemetering mechanical quantities, known as the Chronoflo, has been developed by Builders Iron Foundry, Providence, R. I. This new system accomplishes electrically what the company's original venturi register, brought out 40 years ago, performed mechanically. Such a register combines the elements of a differential mercury column, a rotating cam that extracts the square root of the differential and gives a time period of recording or integrating which is exactly proportional to the flow rate.

Fig. 2 shows a section through the primary, or transmitting, differential unit. When connected with a venturi tube, or orifice, the right-hand mercury column receives the inlet or full-pipe-line pressure and the left-hand mercury column the throat pressure. If the rate of flow increases, the resulting displacement causes the mercury in the right-hand, or float, column to descend and to rise in the opposite column. Displacement is in the reverse direction for a decreasing flow.

Figs. 3 and 4 are simplified diagrams of the transmitting unit. A synchronous motor revolves the cam once per minute. When used for flow metering this cam has a square-root contour. The mercoid switch is moved up and down vertically as the cam rotates and is tilted by the rod which rests on the float in the mercury well. Fig. 3 shows the cam in the neutral position and the tilting rod resting on the float in the mercury.

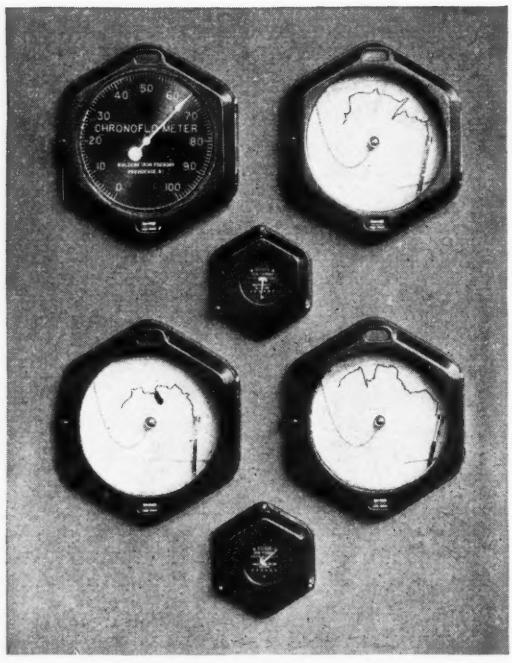


Fig. 1—These meters show records of distant steam and water flow

When the cam has rotated to a position, such as that shown in Fig. 4, the rod has been lifted off the float and the mercury switch has been tilted to close an electric circuit to a relay for transmitting a current impulse to the distant receiving unit. As the cam continues to rotate, it finally returns to the position, Fig. 3, the tilting rod again rests on the float, and the mercury switch tilts to a position to open the transmitting circuit.

The period during each revolution of the cam that the mercury switch remains in the closed position will depend upon the height of the mercury in the well. At zero flow the mercury level will rise to a position where the upper end of the tilting rod will come in contact with the switch to tilt it to the closed position for only an insant. At full-capacity flow, the mercury level will reach a low point where the tilting rod will ride on the mercury switch continuously and will hold it in the closed position, except for an instant to release the increasing clutch during each revolution. Between these two extreme positions, the tilting rod will hold the mercury switch closed for a time period exactly proportional to the flow, and consequently will transmit an impulse of similar time duration to the receiving device.

From the foregoing it is seen that the tilting of the

mercoid switch causes electrical impulses of variable duration to be sent to the distant secondary, or receiving instrument. The mechanism in this instrument, Fig. 5, consists essentially of a synchronous motor driving in opposite directions two bevel gears, which are alternately engaged by drum magnetic clutches.

Energizing of the clutches is controlled through a relay by the electrical impulse received from the primary unit. This relay, when in the open position, energizes the decreasing clutch and when closed by an impulse from the sending unit energizes the increasing clutch. The increasing clutch carries a finger F; the decreasing clutch supports a finger F_1. These fingers are brought into contact by the clutches with the pen-actuating lever and position the chart pen and dial hand once per minute. The totalizing counter is also advanced by the increasing clutch through a lever and ratchet at the same time.

When the clutches are de-energized they return the fingers to the starting position for the next cycle. The angular clutch movement is proportional to the time duration of the primary impulse and hence to the flow rate.

Assume that the flow is increasing. Impulses of increasing duration will then be transmitted to the relay on the receiving unit. This relay will be held closed to energize the increasing clutch for a time duration corresponding to the flow. Finger F on the clutch will be brought in contact with the pen-positioning lever and will move the pen to a position indicating the rate of flow.

When the mercury switch opens in the sender, the receiver relay drops to the open position and de-energizes the increasing clutch and closes the decreasing clutch in the receiver. Finger F_1 then begins to advance toward the pen's positioning lever. Because the flow is increasing, the decreasing clutch will be de-energized before the decreasing finger comes into contact with the pen-driving lever. If the flow continues to increase, the next increasing impulse will be of a longer time duration than the previous one and the increasing clutch will remain energized for a longer time and will move the pen to a higher position. Conversely, the decreasing impulse will continue for a shorter part of the 1-min. interval.

Now, assume that the flow is decreasing. The time duration of the increasing impulses will be shorter, and finger F on the increasing clutch will not be advanced far enough to contact the pen-positioning lever. The decreasing impulses will be proportionately longer. Finger F_1, on the decreasing clutch, will now be brought into contact with the positioning lever to move the pen to a lower position corresponding to the lesser flow rate.

When there is no flow change in the minute interval during which an increasing and decreasing impulse is given to the receiver, the pen is not moved. The clutches will advance fingers F and F_1, which will just contact the positioning lever without moving the pen.

At maximum flow the decreasing clutch will be energized for the full-minute impulse, with the exception of a very short interval to allow the clutch to return to starting position. At zero flow the decreasing clutch is energized for practically the whole minute impulse except for a very short interval to allow the clutch to return to the starting position.

The Chronoflo system is entirely practical over telephone channels which are carrying conversations. There is no limit to the distance or the number of exchanges involved. A recent 500-mile test produced exactly duplicate chart records from recorders at the transmitting and receiving ends, with almost instantaneous response of the latter. The system is equally suitable for private wires or for short distances, such as transmission to a central instrument board within a power plant.

Fig. 1 shows the receiving instrument panel demonstrated at the New York Power Show. The dials at the top of this panel were connected to the Catskill aqueduct of the New York City water system by telephone line and continuously indicated and recorded the flow through a 15-ft. diameter venturi tube, one of the four largest in municipal-water service. The lower-left dials recorded and totalized the flow of steam from one of the boilers in the East River station of the New York Edison Company, the steaming rate being raised to 1,000,000 lb. per hr. for a short period. This record of flow was also transmitted over a telephone circuit.

Mention has been made of some of the uses for which the new device is inherently suited. Among others are problems in which both the hydraulic and mechanical engineer have expressed interest, involve telemetering of such values as reservoir levels, direction of flow in pipe lines, pressures, head in elevated water tanks, boiler-water levels, main-valve positions, draft-gage pressures, water consumption of hydraulic turbines and boiler-feed.

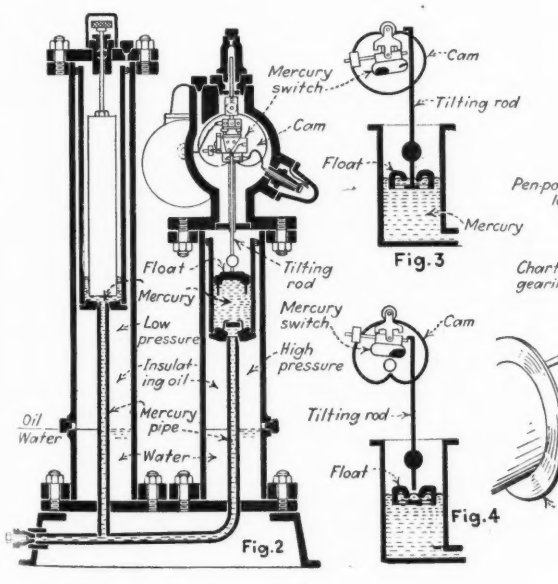


Fig. 2—Section through sending unit

Fig. 3

Fig. 4

Figs. 3 & 4—Operating principle of sending unit

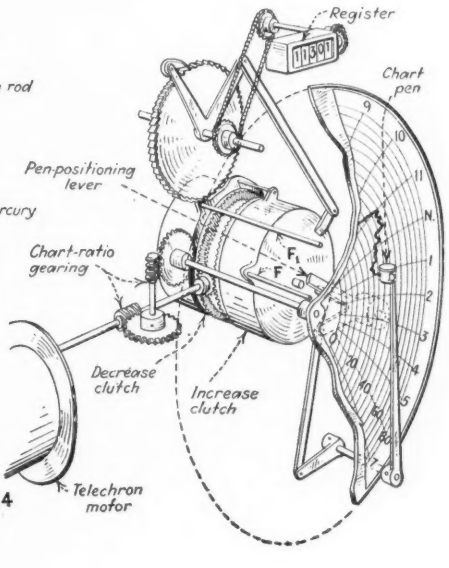


Fig. 5—Diagram of receiving unit for indicating, recording and integrating

Mr. Gould here answers further pertinent questions on coal buying by an editor acting the part of a typical reader. Questions are in bold type; the answers will interest every power engineer

BUYING COAL LOOKS

An Interview with G. B. GOULD,

"LAST month we discussed the difficulty of establishing a basis for measuring the relative values of different coals. Your conclusion, after many years of experience, is that evaporation is a most dangerous guide, because it is influenced by so many factors other than the nature of coal. What index of value would you suggest in place of it?"

"There is no simple yard-stick by which coals can be valued. It requires a considerable amount of information—of exact measurements of various kinds—all of which can be related to produce an accurate appraisal.

"First there are the differences in heat value. These must be determined in the laboratory. Most coal-buying decisions cover a substantial tonnage to be delivered in the future. All coal varies somewhat from one day's output to another. Therefore a laboratory test on one or two shipments is not a reliable guide. An average of ten or twenty shipments will be—the more the better."

"But two coals having the same heat value will not be equally valuable when measured by the results in a plant."

"That is true. Coals differ not only in heat value, but also in various physical characteristics—fusing point of ash, volatile matter, size, coking qualities and grindability, to name some of the more important.

"These physical characteristics do affect operation, but their effect on efficiency can easily be exaggerated. It frequently is, and leads to the mistake of thinking the variations in evaporation among several coals being tried are due entirely to some unknown quality of the coal. If one jumps to that conclusion, he naturally does not look farther, and mistakes these differences in evaporation for a measure of differing coal qualities, when they are really a measure of fluctuating efficiency, due to other causes."

"How can you guard against that kind of mistake?"

"Fuel engineering does it by studying and measuring the *losses* of energy in the furnace and boiler. Part of these losses can be considered, for practical purposes, in a given plant, as uncontrollable. Others have certain practical limits, depending upon the equipment, below which they can not be reduced. In the uncontrollable group is the radiation loss, with which is combined other unmeasured losses. Under the most favorable circumstances this will amount to about 4 per cent of the total heat value of the coal in the typical industrial plant, stoker-fired or hand-fired.

"In such plants this loss is influenced by the number of banking hours and by the load; in pulverized-coal plants by an undetected loss of solid carbon in the flue gases. This may be as high as 10 per cent (sometimes more), but only in the pulverizer plant is it likely to be seriously influenced by the character of the coal. The loss due to moisture and hydrogen in the coal will run about 4 per cent, and varies so little among coals available in any one locality that it can be ignored for purposes of coal selection.

"The two other losses deserve more careful examination. The 'dry-flue-gas loss,' under favorable conditions, will reach a minimum of about 12 per cent, without the aid of economizer or air preheater. Some solid fuel is always lost to the ash-pit of a stoker-fired or hand-fired plant. A reasonable minimum for this is 3 per cent.

"We often find plants operating with a flue gas loss above 20 per cent, or with an ash-pit loss of 8 to 10 per cent. These two losses are very sensitive to plant operation; and they *may* be influenced by the character of the coal."

"You say that these two controllable losses combined may vary from a minimum of about 15 per cent to as much as 30 per cent, due either to operating methods or coal qualities. Which is more important?"

"Usually the methods of operation, or the conditions under which the plant is required to operate; but many industrial plants fail to measure these losses continuously and watch their cause. The result is that they don't realize how much the evaporation is varied by changes of this kind, and assume they are caused by the coal.

"For example, the amount of heat carried away in the flue gas will be affected by any one of three independent causes: (1) rating carried, (2) cleanliness of heating surfaces, and (3) amount of air supplied. The first two operate to increase or decrease efficiency (and consequently the evaporation) without any relation to the fuel being used.

"The third depends upon the adjustment of dampers and fans to the amount of fuel being burned *and* the physical condition of the fuel bed. While proper control of the air supply is primarily a matter of operation, the ability to maintain the most desirable adjustment for minimum stack loss *may* be limited by the character of the fuel.

"Therefore, before assuming that a difference in this

loss is due to the quality of the fuel, it is necessary to make allowance for differences in load, or in the condition of the boiler surfaces and you would need to make sure that the air supply was in fact adjusted properly.

"The loss of solid fuel in the ash-pit will also vary with the load, and allowance must be made for that in comparing results with different coals."

"Is it practical to do this?"

"Yes. You need only adequate records of the several factors, and analysis of the results in the light of those facts. Of course, it takes experience, and it requires technical resources which are not always all available in an industrial plant. Fuel engineering supplies them, and supplements the operating engineer's personal observations to bring about a reliable appraisal of values. It opens up a wide field of choice and frees the plant from the cost and trouble of frequent trials of different coals.

"There is this added advantage. This way of going at it places the responsibility for operation on the operating force, when it belongs there, but puts it on the coal when it belong there. It means not only better coal selection, but a closer control of operating efficiency."

"What are the physical characteristics of coals which may influence their value?"

"To answer that question, it is necessary to distinguish carefully between coal qualities which may influence efficiency, and those which make a coal definitely undesirable for other reasons. For example, if a coal makes smoke, no matter how it is fired, and the plant is situated where there are strict smoke regulations it can not be selected regardless of the evaporation or the cost. The same applies to a coal that produces serious clinker trouble. This is probably the most important single characteristic of coal."

"Is there any way to predict whether a given coal will clinker, without trying the coal in the plant?"

"That is one of the most important contributions of fuel engineering to coal selection. By the accumulation of years of operating records, along with complete coal quality records, it has become possible to relate a given plant's operating requirements very accurately to the required fusing point of ash.

"The practical advantage of this is two-fold. First, the plant avoids fruitless experiments with coals that are sure to give clinker trouble. Second, it is no longer necessary for the buyer to purchase only a few very high fusing point coals, just to "play it safe." Any unnecessary limitation on coal selection in the end costs money."

"If a coal clinkers in one plant, why doesn't it clinker in all other plants?"

"Some buyers think that is so, and as a result avoid coals that are actually all right for their plants, just because they have heard the coal clinkers somewhere else. Yet it may happen that, with two boilers of the same rating, carrying the same load, the same coal will clinker under one and not under the other."

"Why is that?"

"Either one of two reasons. The grate area under two boilers of equal rating is not necessarily the same. If you have less grate area, more coal must be burned per square foot of grate per hour for a given output of steam. There is a definite relation between this rate of combustion and the fusing point needed to avoid clinker trouble. No two plants are necessarily operating with the same combustion rate.

"Then, too, even with the same combustion rate, the furnace temperature will vary with the CO_2. So you have to know that, and its relation to furnace temperature."

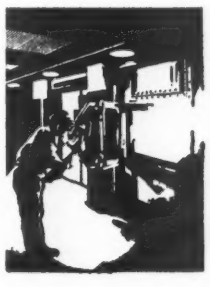
"I take it then, that fuel engineering looks at coal selection as a matter of matching coal characteristics, which can be measured in the laboratory, with plant characteristics, which can be determined. Some are important in one plant, others in another. If you know how these factors fit together, coal selection becomes more exact, quicker, easier, and free from the uncertainties of plant trials."

"Yes, that is one of the most important things that fuel engineering has contributed to the conduct of American industry. Most plant trials of coals can be eliminated if you have enough accurate information about the coals and about the plant. They should be used only to confirm a fuel-engineering forecast. For that purpose they are desirable. There are minor differences among coals, with respect to their physical action in the furnace. But no one should take comparative evaporation figures as a reliable measure of the relative values of different coals, unless they have definitely eliminated or allowed for the variations due to purely operating factors. In this, coal selection is like a lot of other problems in which failure to segregate controlling factors leads to wrong results."

EASY—BUT IT ISN'T!

President, Fuel Engineering Company of New York

[This interview is concluded in this issue. The first half appeared in the May number under a similar heading. Readers are invited to discuss, briefly, the points raised by Mr. Gould and his questioner.—Editor.]



Performance of Two 101,000-Sq.Ft. SURFACE CONDENSERS

By J. N. LANDIS & S. A. TUCKER
Brooklyn Edison Co.

At Hudson Ave. Station of the Brooklyn Edison Company are installed two 101,000-sq.ft., single-pass condensers of radically differing design, serving identical 160,000-kw. turbines. This paper, printed for the A.S.M.E., gives a summary of test results on these two units and is to be presented at the Society's meeting in Chicago, June 26-30

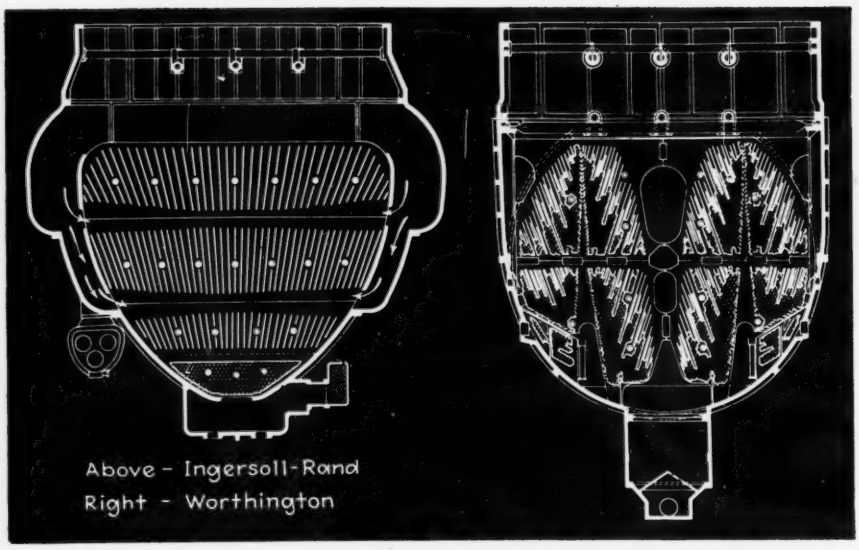


Fig. 1—Transverse sections through condensers, showing steam-flow lanes

THESE two condensers have been extensively described in detail elsewhere,[1] and therefore only a summary of their design is given. The steam-flow path of the Worthington condenser, Fig. 1, is through an effectively shallow tube bank of the folded layer type, having deep inlet lanes to facilitate the passage of steam with minimum pressure drop. The entire tube bank is contained in a practically cylindrical shell. In the Ingersoll-Rand unit, the generally heart-shaped shell maintains with a decreasing volume of steam an active flow over all tubes. By-pass lanes around top sections of tubes allow part of the steam to reach lower tube banks without passing through top section.

The Worthington air cooler is internal to the shell, it being the most convenient location and involving the least costly construction. The Ingersoll-Rand design uses an external air cooler to provide a more efficient design of flow areas.

Reheating is provided for in the condensate circuits of both units, the Worthington using a contact-type reheating hotwell integral with the condenser and the Ingersoll-Rand having a 1,600-sq.ft., surface-type, closed reheater after the condensate pump, supplied with steam from one of the top by-pass belts.

In the Worthington unit, free longitudinal flow of steam is permitted by openings cut in the six tube-support sheets. Quite in contrast, the Ingersoll-Rand unit, Fig. 2, is divided into five separate longitudinal compartments by four closely fitted tube-support sheets. Each of the three cold-end compartments is separately connected to its own section of the external air cooler, and the two warm-end compartments are connected in parallel to the remaining section of the air cooler with a throttle plate to limit flow from the end compartment.

Air removal is accomplished on the Worthington unit by a three-element two-stage steam jet, and on the Ingersoll-Rand unit by eight primary and three secondary jets.

Each condenser is served by two circulators with separate water circuits from inlet to discharge tunnels. The Worthington unit has a conventional vertically divided waterbox, whereas the Ingersoll-Rand waterbox is divided into four horizontal sections, arranged for each circulator to supply two alternate sections.

Acceptance Tests

These tests represent the culmination of several years' experience in performing tests on large power plant equipment, including several condensers, by a group of test men organized principally for acceptance testing. Results are presented with the belief that they summarize the most comprehensive and carefully executed condenser tests publicly reported.

Tests were unusual in that they determined the "cleanliness ratio" of the condensing surface. Cleanliness-ratio measurement has already been discussed in detail before the A.S.M.E. by Hardie and Cooper.[2] The test determined the individual performance of thirty isolated tubes in various parts of the condensers, arranged in six groups of five tubes each, supplied with independently controlled circulating water. Each group of five tubes contained two new tubes and three existing used tubes representing condensing surface condition at time of test. One new tube in each group was supplied with salt water and the other, for purposes of a separate investigation, with fresh water. The ratio of average thermal transmittance of the used tubes to average transmittance of the salt-water new tubes was taken as condenser "cleanliness ratio." In their contracts, these condenser manufacturers and all others made guar-

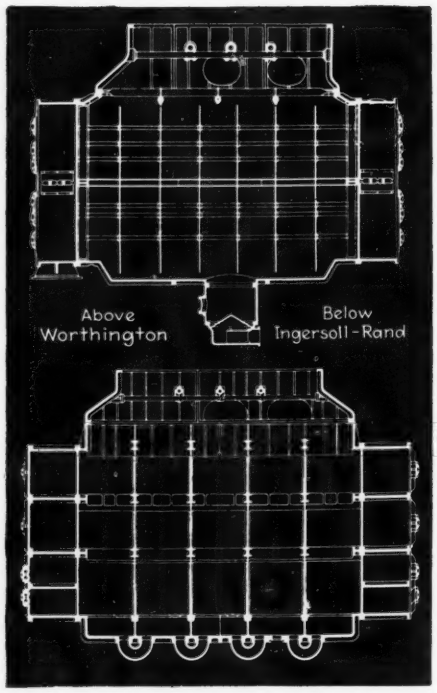


Fig. 2—Longitudinal sections through condensers, showing longitudinal distributions of steam

[1] *Power Plant Engineering*—April 15, 1932. *Power*—May 31, 1932. *Power Plant Engineering*—November, 1932.

[2] "A test method for determining the quantitative effect of tube fouling on condenser performance." By P. H. Hardie and W. S. Cooper, abstracted in *Power*, March, 1933.

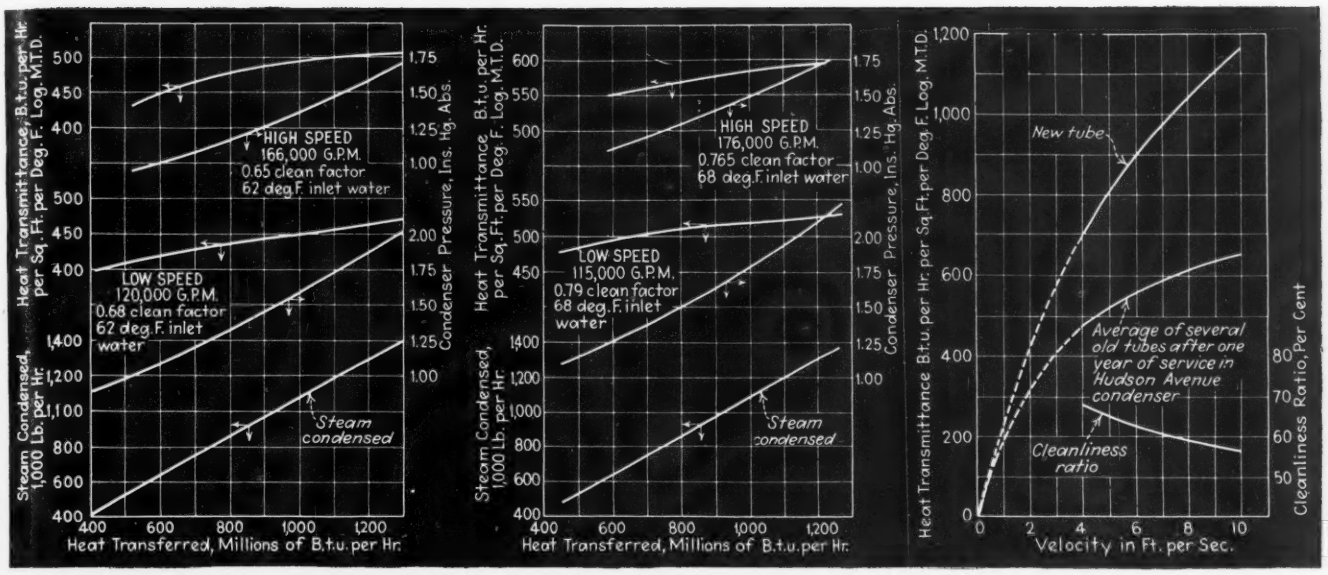

Heat Transmittance, B.t.u. per Hr. per Sq. Ft. per Deg. F. Log. M.T.D.
Condenser Pressure, Ins. Hg. Abs.
Steam Condensed, 1,000 Lb. per Hr.
HIGH SPEED
166,000 G.P.M.
0.65 clean factor
62 deg. F. inlet water
LOW SPEED
120,000 G.P.M.
0.68 clean factor
62 deg. F. inlet water
Steam condensed
Heat Transferred, Millions of B.t.u. per Hr.
HIGH SPEED
176,000 G.P.M.
0.765 clean factor
68 deg. F. inlet water
LOW SPEED
115,000 G.P.M.
0.79 clean factor
68 deg. F. inlet water
Steam condensed
Heat Transferred, Millions of B.t.u. per Hr.
Heat Transmittance B.t.u. per Hr. per Sq. Ft. per Deg. F. Log. M.T.D.
New tube
Average of several old tubes after one year of service in Hudson Avenue condenser
Cleanliness ratio
Cleanliness Ratio, Per Cent
Velocity in Ft. per Sec.

Fig. 3—Performance curves for Worthington condenser

Fig. 4—Performance curves for Ingersoll-Rand condenser

Fig. 5—Individual tube performance from Ingersoll-Rand tests made in 1929

antees which were to be corrected downward from a 100 per cent clean transmittance guarantee in direct proportion to the cleanliness ratio obtaining at time of test.

Nine one-hour runs, confined to a period of two days, were made on each condenser. These runs covered the normal operating range of the turbine for both high and low speeds of circulating pumps. During the night preceding the start of test runs, each condenser was completely rubber plugged to secure uniformity of tube condition and thus the most representative cleanliness ratio as measured from the relatively few sampling tubes.

Acceptance Test Procedure

Readings were taken at 5-min. intervals of:

1. Inlet circulating water temperature by two precision mercury thermometers graduated to 0.1 deg. F.

2. Outlet circulating water temperatures by six precision mercury thermometers graduated to 0.1 deg. F.

3. Absolute pressure at steam inlet by eleven specially constructed absolute pressure gages connected to an equal number of basket-type pressure tips distributed over area of turbine exhaust.

4. Absolute pressure at (each compartment of) hotwell by absolute pressure gages identical with those used at turbine exhaust.

5. Condensate temperature leaving hotwell (and reheater) by precision mercury thermometers.

Steam condensed was weighed in the station weighing tanks. Sufficient readings were taken of turbine throttle and feed heating conditions to permit computing the heat content of the exhaust steam.

To ascertain the condenser cleanliness factor during the period of test, six groups of isolated tubes were connected by rubber hose to a separate supply of salt water measured at the outlet end by a calibrated bell-mouthed nozzle. One new tube in each group was supplied with fresh water as a reference standard to indicate any tendency of the salt-water new tube to foul. Flow of water in each tube was held approximately the same as the average of all the condenser tubes. For measuring the temperature rise in each tube, mercury thermometers were inserted through rubber stoppers directly into the water stream.

Air offtake temperatures were measured by mercury thermometers inserted through rubber stoppers, and air leakage was determined from the standard equipment furnished by each manufacturer as part of the contract.

Pressure drops for each part of the circulating water system and total and suction heads on the pumps were determined by mercury U-tubes. Electrical input and speed of the circulator motors were also separately measured.

Principal test data is tabulated in the table. Fig. 3 shows for the Worthington unit the absolute pressure and the calculated heat transmittance coefficients obtained for both high- and low-speed pump operation. Fig. 4 is a plot of the same results obtained on the Ingersoll-Rand condenser.

Someone may question why curves of both tests show different cleanliness ratios at low and high speed on the circulators. Fig. 5 shows the results of calorimeter measurements performed by the Ingersoll-Rand Co. in 1929 on several used tubes taken from a Hudson Ave. condenser and on two sections of new tube. This test work illustrates that dirty tubes do not respond to increases of velocity as do clean tubes. This condition is explained by the fact that an increase of water velocity effects a reduction only in the resistance to heat flow of the water film, which is a much smaller proportion of the total

Actual Condenser Test Performance

Run No.	Date 1932	Steam Condensed Lb. per Hr.	Heat Transf. by Cond. Million B.t.u. per hr	Abs. Pressure at Condenser Nozzle, in. Hg.	Hotwell Temp.[1] Deg.F.	Cir. Water Temp. Out Deg.F.	Cir. Water Temp. In Deg.F.	Cir. Water Flow G.p.m.	Condenser Friction[2] A ft.	Condenser Friction[2] B ft.	Heat Transmittance B.t.u. per hr. per sq.ft. per deg.F. Log M.T.D.	Clean. Factor	Air Removed, c.f.m.	Avge. Temp. Air Offtake, deg. F.
Worthington Condenser														
						HIGH SPEED								
1	6–13	732,100	684.0	1.09	81.7	71.6	63.3	167,800	†	17.3	490	0.68	**	76
5	6–13	562,900	531.4	0.93	76.5	68.1	61.6	165,400	†	17.7	455	0.68	4	73
6	6–14	995,800	923.4	1.36	88.5	74.0	62.7	166,500	17.3	17.6	463	0.61	5	82
9	6–14	1,389,700	1,282.1	1.82	97.7	77.5	61.9	167,800	17.9	17.7	459	0.59	5	90
10	6–14	731,300	682.1	1.09	81.7	69.9	61.4	163,800	17.9	17.9	432	0.59	6	79
						LOW SPEED								
2	6–13	721,600	675.3	1.20	84.2	74.1	62.7	120,500	†	9.5	449	0.72	4	79
3	6–13	432,600	416.4	0.89	75.6	68.9	61.7	118,300	†	9.5	421	0.72	5	72
4	6–13	568,700	536.4	1.01	79.5	71.0	61.9	119,500	†	9.7	425	0.71	4	76
7	6–14	992,600	920.9	1.57	92.8	78.4	62.9	121,200	9.6	9.7	422	0.64	5	87
8	6–14	1,395,500	1,286.2	2.13	102.9	83.1	61.6	121,900	9.7	9.6	428	0.62	5	96
11	6–14	735,900	684.5	1.21	84.9	73.1	61.5	119,800	9.9	9.9	399	0.60	6	81
Ingersoll-Rand Condenser														
						HIGH SPEED								
5	6–27	643,000	601.7	1.10	82.1	74.3	67.3	176,400	15.6	14.7	553	0.78	4	78
6	6–28	1,008,100	932.3	1.46	90.7	79.4	68.5	175,300	14.5	15.2	563	0.75	4	85
9	6–28	1,350,300	1,249.5	1.80	97.0	82.7	68.2	176,300	14.3	15.4	576	0.74	2	91
10	6–28	768,600	714.1	1.22	85.3	75.9	67.6	175,100	14.3	15.3	551	0.74	2	81
						LOW SPEED								
3	6–27	487,200	463.2	1.08	81.3	75.5	67.3	115,500	7.1	6.8	493	0.82	4	80
4	6–27	643,100	602.1	1.24	85.8	78.1	67.4	115,300	7.0	6.8	493	0.81	4	83
7	6–28	1,012,000	935.3	1.75	96.5	85.4	68.6	113,600	7.0	6.8	501	0.77	2	92
8	6–28	1,361,000	1,256.9	2.26	105.2	90.5	68.1	114,500	6.8	6.8	513	0.76	2	99
11	6–28	772,550	717.6	1.40	89.9	80.7	68.0	114,900	6.8	6.8	496	0.76	2	86

[1]For Ingersoll-Rand temp. at reheater outlet. [2]Feet of salt water. †Gage inoperative. **Air leak found after first half hour.

resistance in the case of a dirty tube than in the case of a clean tube.

Conclusion

It is natural to expect this paper to make a final comparison of the performance of the two condensers. To do this it would be necessary to make corrections to the test results because of the unavoidable differences in test conditions relating to cleanliness, circulating water quantity, and circulating water temperature. Manufacturers' correction for cleanliness has been discussed in this paper and the correction factors commonly used by condenser manufacturers for the effect of circulating water velocity and temperature are available in the technical press,[1] but the author doubts the soundness of these, especially the cleanliness correction, for making accurate comparisons where large differences are involved. Recent test work confirms the inaccuracy of a straight line cleanliness correction. Because of the uncertainties of corrections, the author feels it better to confine this paper to the reporting of test facts and to leave to others the making of comparisons.

[1]Commercial Factors for Designing Surface Condensers—*Power*, Sept., 1932.

Test results are believed to show fairly the performance of two modern condensing units under as closely parallel conditions as it is practical to secure.

Both condensers perform satisfactorily, and in their ability to hold materially better than guaranteed full-load vacuum they have exceeded expectations by a comfortable margin.

It is hoped that these tests will contribute to bringing the knowledge of condensers to a state comparable with that of turbines.

Acceptance tests were performed under the direction of P. H. Hardie, test engineer of Brooklyn Edison Research Bureau.

OPERATION at SOUTH AMBOY

By R. C ROE[1]
Jersey Central Power & Light Co.

SOUTH Amboy (N. J.) Station contains two 25,000-kw. double-deck turbines. Steam is generated in three pulverized coal-fired boilers, each with 7,214 sq.ft. of heating surface, at 1,400-lb. pressure and 750 deg. temperature. Other elements of the steam generating plant are air heater, economizer, superheater, de-superheater, gas reheater and steam reheater. Feed water is heated in direct-contact bleeder heaters.

Coal is stored in silos exterior to the building which feed by gravity to pulverizer feeders and thence through weighing devices to the pulverizers. These silos are of the vertical concrete type, supported from the ground, and replace the more usual overhead bunker arrangement. This type of active coal storage was selected, first because of its lower cost, and, second, because it relieved the building steel and foundation of the weight of bunkers, which was particularly important because of the poor foundation conditions that existed at the site.

There is nothing new about storing coal in a silo, but most coal stored in this way is either lump bituminous or anthracite, and engineers questioned how well the crushed bituminous would flow, particularly when wet.

The silo has been comparatively free from troubles due to improper coal flow, although these troubles have not been entirely absent. To eliminate such troubles as did exist, pitch of the silo bottoms was increased, and the material in the bottom was changed from a plain concrete to a mixture of Portland cement, sand and flake graphite which was trowelled and dressed down smoothly. Since these changes have been made, coal silo difficulties have been largely eliminated, with the exception of those with coal from one particular mine in West Virginia.

[1]From an A.S.M.E. Metropolitan Section paper, this abstract deals primarily with operating experiences. Sufficient time has elapsed since installation of the station to permit proper evaluation.

Ball-Mill Type Unit Pulverizers — Five ball-mill unit pulverizers are installed per boiler, giving an increment load of approximately 5,000 kw. per pulverizer. Each pulverizer serves a single burner. Operation of these pulverizers has been very successful. Maintenance costs are well under two cents per ton, their reliability is excellent, the pulverizing room is free from dust and dirt, they are reasonably quiet, and the power consumption, although higher than that with some other types of mills, has not been excessive.

The pulverized coal burners were constructed as part of the water-cooled furnace walls and cooled by the water-wall tubes. No air is passed through the burner for cooling purposes when idle. The number of burners in operation is controlled by the load on the unit. In no case is the load on an individual burner allowed to fall below 50 per cent of normal rating. This permits better functioning of the burners, inasmuch as air velocities in the primary and secondary air streams are, in actual operating practice, nearly the calculated velocities. All regulation is usually done on one burner, with the other burners in service operating at rated capacity.

Fuel and air are measured before entering each individual burner, and by this means they are proportioned to give proper combustion before entering the furnace. That this arrangement might be effective, and so improve combustion, special precautions were taken in sealing the furnace corners and burner openings, and in construction of burner dampers to prevent air infiltration. These dampers were equipped with fabric edges to make tight joints and were mounted on ball bearings for easy operation.

Coal fed to the pulverizers is weighed in such a way that it may be translated into rate of flow. This rate of flow is transmitted by means of Selsyn motors to one element of a three-element combustion control meter. Air is measured in two sections, that is, primary air and secondary air, primary air amounting to

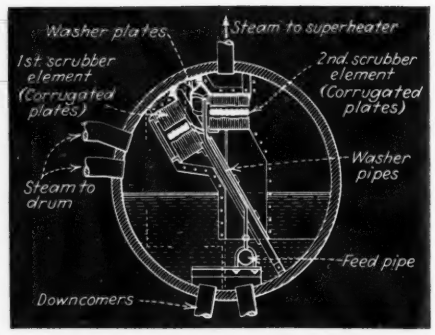


Fig. 1—Steam is washed and moisture separated before leaving boiler drum

30 per cent of the total, and secondary air 70 per cent. Meters measuring the volume of air flowing are compensated for absolute temperature, so that the weight of air actually flowing may be obtained. Thus, the flow of both air and fuel is obtained in pounds per hour.

These three readings are assembled in a single meter with three pointers, and with an indicating scale at the bottom of each pointer which gives the true pounds of coal or air per hour, and a rating scale at the top of each pointer giving the percentage of burner rating.

In operation, these instruments required considerable adjustment during the first few months of initial operation, after which they have functioned with remarkable satisfaction and a high degree of accuracy. They are considered an almost indispensable aid to proper firing of the boilers and maintenance of the high station efficiency.

Adjustments of the quantities of coal and air are made manually by means of remote control switches and indicating lights. One operator can readily handle a boiler turbine unit of 25,000-kw. capacity from the boiler-room control board, including the adjustment of all combustion control and maintenance of steam pressure, water levels, etc. In an emergency, he could handle two of these units.

Impulse-Type Burners—At the time the station was designed there was in process of development a new burner for handling pulverized coal, the im-

pulse-type burner. These were installed on No. 2 boiler, while Calumet burners were installed on the other two.

These burners were installed with long, narrow, coal and primary slot running vertically in the furnace. On each side of it were ports to admit secondary air. Ports were controlled by two rotating valves, and the whole burner was divided into increments of about 8 in. vertically. Rotating valves were geared together similarly to the gearing of an automobile engine camshaft, and, therefore, operate in fixed relation. The result is incremental slugs of secondary air of contrary motion, 8 in. in height, entering the furnace from opposite sides, changing 1,000 or more times a minute.

As the speed of the valve mechanism is increased, the flame becomes shorter and shorter, and more intense, which would indicate that, with a high-speed design, furnace volumes could be materially decreased without additional punishment to the furnace water walls.

The burners gave much trouble in the early part of their installation, from lack of knowledge of expansion stresses. These mechanical difficulties have been corrected, and burners are functioning in a satisfactory manner, although their initial construction does not permit operation at speeds now demonstrated to be desirable.

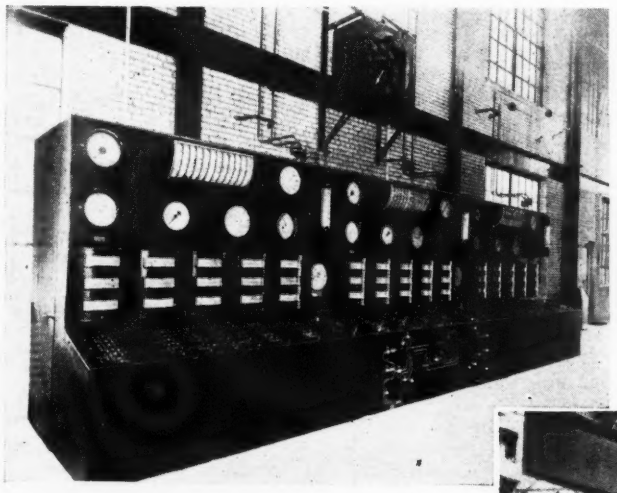
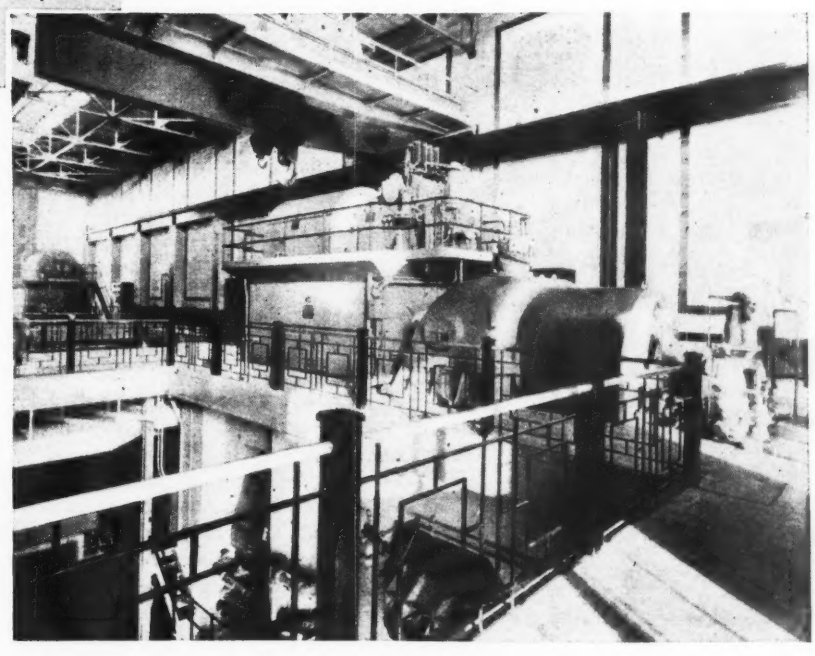


Fig. 2 — The three boilers are operated from this control board

Fig. 3—Two 25,000-kw. double-deck turbine generators are installed at South Amboy



As in other high-pressure plants, there has been trouble with boiler feed pumps, and changes have had to be made in their design. The direct-contact heaters helped this condition, because they permitted pump changes impossible with closed heaters. Water has been put into the economizers of the South Amboy station from the bleeder system at temperatures as high as 525 deg. for considerable periods of time. This is believed to be the highest temperature water ever taken from bleeder heater systems on turbines.

Water Purification and Carry-Over—It early became apparent that water purification and boiler carry-over was a problem of prime importance. There were two causes: (1) the character of the water which was available at the station, and (2) the small size of the high-pressure turbines, which made them more susceptible to boiler carry-over conditions.

On the evaporator side of the cycle, changes were made in design by installation of foam baffles and high-velocity separators, resulting in a purity of water of better than 0.3 grain of solids per gallon. In addition to this, pretreating the evaporator feed was resorted to, to permit proper preparation of the water and releasing of all CO_2 in the water prior to entering the evaporator.

Boiler-drum baffles were removed from the boilers, and new baffles, then under development, were installed, first in one boiler and later in all three. Prior to these changes, the best the plant could do was a carry-over amounting to about 8 to 10 parts per million in the steam from the boiler.

In designing the new baffles, it was recognized that most of the solids were unquestionably carried in the moisture, and that the quantity of moisture, and the solid content of this moisture, were therefore the factors controlling carry-over.

A scrubbing-type corrugated baffle was installed in two sections. The first section provides a high velocity through impingement surfaces by which the moisture particles come in contact with corrugated plates which remove all but a small percentage of the moisture. The second step is to wash or to scrub this steam by means of sprays of boiler feed water in the form of condensate. This is fed in as a spray immediately after the corrugated separator, washing out and combining with the moisture contained in the steam as it leaves the first separator, and also diluting the solid content of the moisture contained in the steam. The moisture and steam then pass through a second set of high-velocity corrugated baffles where the moisture content is reduced to a minimum and drained to the boiler drum.

On tests, boiler concentrations were built up from the normal operating point of 100 parts per million to as high as 2,350 parts per million, with the water level 2½ in. above the center line of the water column. Under these conditions, the solid content in the steam leaving the boiler was found to be 0.20 parts per million. With normal concentrations now running between 300 and 400 parts per million, consistent records are obtained running from 0.2 to 3 parts per million total solids in the steam.

Although a pH value of 10.8 has been consistently maintained in the boiler water, the steam condensate, after passing these purifiers, was practically neutral, and it is necessary to start the boiler water treatment in the condenser hotwell to prevent corrosion in piping, pumps or heaters. Prior to installation of this equipment, the turbines sometimes became incrusted to the extent of building up the first-stage pressure drop as much as 150 lb. in four or five days.

The furnaces as originally installed were equipped with a coke floor. This floor, in common with similar ones in other stations, has failed on No. 1 and No. 3 boilers, and has been replaced with a water-cooled floor as part of the water circulation.

During the month of February, 1933, the B.t.u. per net kw.-hr. was 12,508. The coal per kw.-hr., including all banking fuel, was 0.901 lb. per net kw.-hr. Over-all boiler efficiencies, month in and month out, are in the high eighties.

• • • • POINTS • • • •

IN GAS ANALYSIS

IN A general way, gas analysis by instruments of the Orsat type is understood by most power engineers. However, many who make such analyses occasionally, and some who make them frequently, use an inferior technique which reduces accuracy and wastes time. These comments are directed to the engineer who has operated instruments of this type, but who may not be familiar with the most modern technique for their operation.

The most common mistake is to deliver the gas slowly from the burette to the absorbing pipette. This has several disadvantages. If the total time from the beginning of transfer of the gas to the pipette to its complete return is kept constant, slower transfer means slower average contact time. Gas in transit is not "working." For example, if the gas is passed over steadily for fifteen seconds and then immediately started back and withdrawn steadily for the same period, it is obvious that the last bit of gas entering the pipette is immediately removed and that this portion is not properly exposed to the absorbing reagent. Exposure of other portions varies all the way from zero to the full thirty seconds.

To get the best use of the 30 sec. total time assumed, the complete gas charge should be passed over in the shortest possible time, left in the pipette as long as possible and then withdrawn completely at high speed. In the case just cited, with 30 sec. total available time, all of the gas will be exposed to the absorbent for at least 20 sec. if the time of transfer is reduced to 5 sec. for each operation.

Actually, of course, the required soaking time will depend on several factors. With the most modern equipment and reagents, soaking time may be as little as 5 sec. for O_2 and even less for CO_2.

There is another important reason for rapid transfer of the gas from the measuring burette to the absorbing pipette. As is well known, absorption occurs mainly on the large wetted surface of the material used to pack the pipette. After the liquid level is lowered, this liquid drains off, rapidly reducing the absorbing action. If the gas is passed over slowly, much of the liquid will have drained from the upper part of the absorbing material before the last portion of the gas has entered the pipette.

These and other fine points of gas analysis have been studied at length by The Hays Corporation, who have, at the request of *Power,* supplied the accompanying photographs and the information upon which these brief comments are based.

The three most important points are illustrated by the photographs and described in their captions. Fig. 1 shows how the gas may be passed over rapidly by raising the leveling bottle high and using the rubber tube as a stop valve. Fig. 2 shows the best leveling technique, with case hung to bring liquid surfaces at natural eye level and with back of case swung open for full lighting. Fig 3 shows the cleanest and simplest method of introducing a new charge of reagent into the reservoir.

Fig. 1—Remember gas in transit is not "working" with reagent. To save time in analysis, speed up transfer of gas from burette to absorption pipette. With pipette valve wide open, raise leveling bottle high. To nip flow when water reaches etched line at top of measuring burette, clamp rubber tube with base of thumb as shown. Do not retard flow until last possible moment. Then, still clamping tube, lower hand to comfortable level while gas is soaking. After absorption, return gas to burette at high speed by reversing the carry-over process with bottle well below level of case. Do not close pipette valve until transfer is complete. Rubber bulb shown below case has two check valves and is used at start to pump sample from line down through burette and bottle.

Fig. 2—Leveling off is simpler and more accurate if cabinet is hung at eye level. Steadying the leveling bottle against the side of the cabinet, move it until the two liquid levels are the same. With eye on this same level read bottom of meniscus in the burette against the graduated scale.

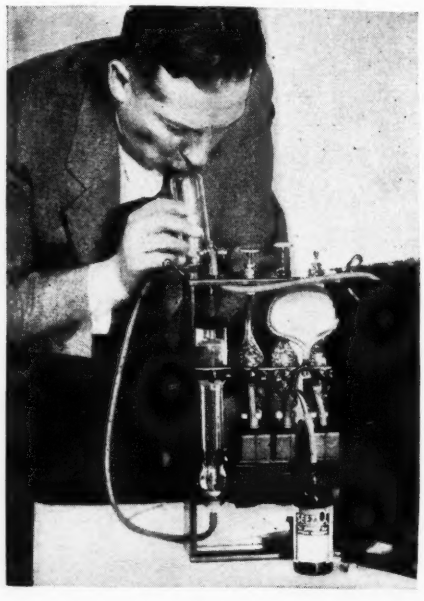


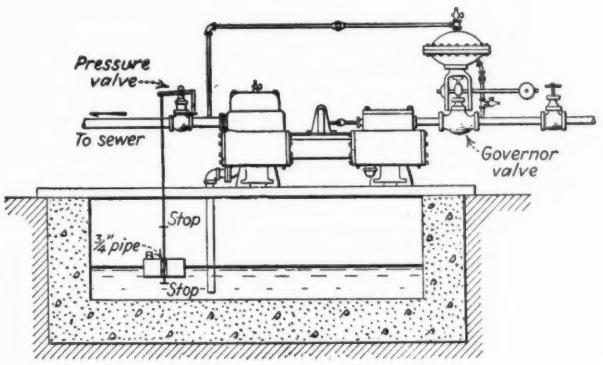
Fig. 3—To refill pipette reservoir without funnels, run syphon into reagent bottle as shown. Draw it over by burette suction produced by lowering the leveling bottle or by sucking on the burette bottle as indicated

PRACTICAL AIDS TO OPERATION

Back-Pressure Governor Controls Steam-Pump Operation

A STEAM-driven, piston-type, sump pump regulated by a float-controlled throttle valve gave considerable trouble because of valve stem binding. This prevented positive closing off of the steam and allowed all the water to be pumped from the sump and the pump to lose its prime.

To overcome this trouble, as shown in the diagram, a governor valve was installed in the steam line and a pressure valve was put on the pump discharge. The valve was made from an old globe valve with the thread filed off the stem. All packing was removed from around the stem, the small amount of water leakage being allowed to run back into the sump. A float was made from a square can with a piece of $\frac{3}{4}$-in. pipe run through



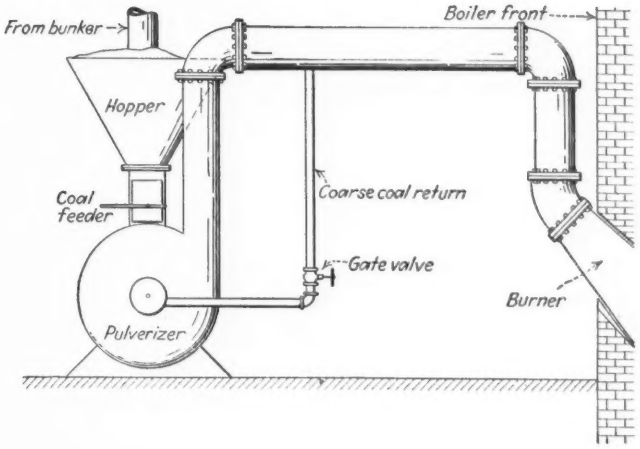
its center and soldered at the top and bottom. This pipe formed a hollow center through the float to permit it to move up and down the valve-operating rod. The float was ballasted by filling it half full of water.

With this arrangement, when the water rises in the sump to a predetermined level, as determined by a stop on the valve-operating rod, the back-pressure valve is opened, which in turn reduces the back pressure on the governor valve and causes it to open and start the pump. When the water is pumped out of the sump to a given level, the float strikes the lower stop on the valve-operating rod, closes the pressure valve and causes the back pressure to increase on the governor-valve diaphragm, closing the steam valve and stopping the pump. By having the float ballasted, the lower the water is in the sump, the more positively the pressure valve is closed. Since this system of control has been installed there has been no trouble with pump operation.

Franklin, Tenn. E. R. HALLAM.

Recirculation Connection Improves Coal Pulverization

ONE pulverized-coal plant using the unit-mill system found it practically impossible to obtain fine enough pulverization with a certain grade of bituminous coal. Other factors, including price and combustion characteristics, made this coal desirable if changes could be made to pulverize it properly.



When passing from the pulverizer to the burners, the heavier particles of the coal would settle to the bottom of the duct, causing the coarse coal to dribble out at the bottom of the burner. This coal caked on the furnace wall under the burner, overheated the burner and damaged the refractory surface.

Overhauling of the pulverizer, together with careful adjustment of air supply, failed to correct the trouble. It was then decided to run a $1\frac{1}{2}$-in. pipe line from the under side of the burner duct back to the intake end of the pulverizer, as in the figure. The heavier particles of coal flowing along the bottom of the duct drop into this line and return to the pulverizer. A gate valve is provided in this line to regulate the amount of coal returned. This arrangement has proved satisfactory.

Milford, N. J. HARRY M. SPRING.

Moisture and Its Effect in Air-Compressor Cylinders

ONE OF the troubles experienced in air-compressor operation is excessive wear, which has been found to take place in the upper part of the high-pressure cylinder and to a lesser extent in the intermediate cylinder. This is usually charged to incomplete lubrication at those places, which in turn is due to the presence of moisture carried in, and along with, the air.

It is known that the percentage of moisture in a given volume or quantity of air increases rapidly during the period of compression, in the same ratio as the pressure of compression. If the humidity of the air in a given case is 50 per cent at 15-lb. pressure abs., it will be increased to 200 per cent when the air is compressed to 60 lb. abs. This means, that one-half of the moisture present in the air would have to be deposited in the cylinder, assuming that the *temperature* of the air remains the *same* during compression. However, the temperature increases and counteracts the increase in humidity due to compression. Suppose, for example, that a given quantity of air at a temperature of 80 deg. F. has 100 per cent humidity. This would be reduced to 50 per cent if the air is heated to 100 deg. In other words, the capacity of air for holding moisture doubles,

approximately, with each 20 deg. F. rise in temperature.

Due to the rapid increase in temperature of air during compression, its capacity for holding moisture increases to a point at which no trouble occurs from moisture on the cylinder walls. When the air passes from the low-pressure cylinder into the inter-cooler, its ability to carry moisture decreases with the temperature. All moisture in excess of 100 per cent humidity will be deposited and flow to the water separator, while the air with its 100 per cent humidity passes to the second-stage cylinder.

The same condition exists in the second- and third-stage cylinders as that described for the low-pressure cylinder. No moisture is deposited during compression, but when the temperature of the air is reduced after passing through the discharge valves to the cooler, a part of the moisture is taken away.

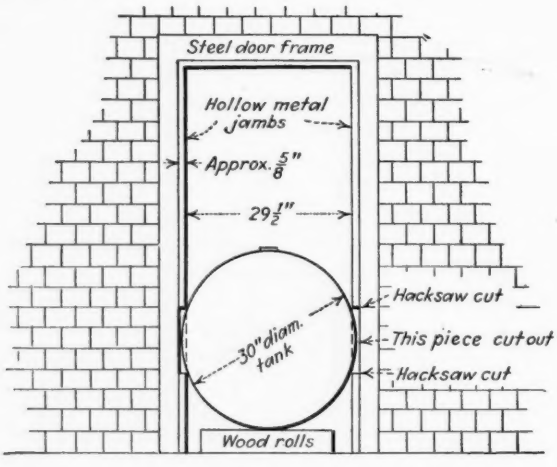
Due to possible faulty draining from whatever cause, some of the moisture that had been set free passes into the second- and third-stage cylinders along with the air. This tends to wash off the lubricating oil from the upper part of the cylinder.

With normal attention and care to the drainage of moisture from the system, proper lubrication can usually be maintained. In cases where moisture still persists, then a suitable compounded lubricating oil should be used. This will resist being washed away and will form with the moisture a fine lubricating emulsion. Care must be taken, however, to avoid an excess of oil in all cases, in order to prevent carbon deposits.

Brooklyn, N. Y. CHARLES J. MASON.

One Way of Taking a Tank Through a Door

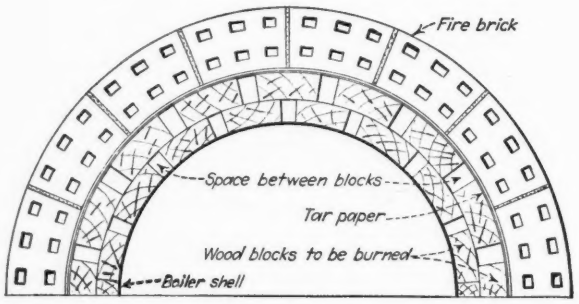
A PIPING contractor on a state hospital building went into receivership. Several weeks passed before the bonding company awarded the job to another piping firm. Meanwhile, the general-construction contractor had gone ahead with his work. When the new piping contractor



came on the job he was confronted with the problem of getting a 30-in. diameter hot-water tank through a door frame which measured 29.5 in. between jambs. The state inspector insisted that the masonry be torn out and the door removed, at the expense of the piping contractor.

The piping contractor hit upon a simple solution to his difficulty. The door frame was made of pressed steel with hollow-metal jambs and had been given a priming coat of paint. On a Saturday, when no other men were at the job, the contractor's mechanics removed with a hacksaw and small diamond-point chisel a piece of metal from each door jamb as shown. This just permitted the tank to be moved through the door. After the tank had been landed in the room the pieces which had been sawed from the door jambs were replaced, carefully soldered in position, and the jambs touched up with paint so that the repair was not noticeable. When the inspector returned to the job on Monday he was amazed to find the tank in its proper location with no apparent clue as to how it had been placed there.

Arlington Mass. T. W. BEAN.



Burning Blocks to Create Boiler Air Space

WHEN we installed a steam boiler in a small isolated station, the setting plans called for an air space on top of the boiler between the shell and the brick covering. The problem was solved by cutting a number of dry 2-in. x 6-in. soft wood blocks, 1 in. thick, soaking them with kerosene and then placing two layers of the blocks loosely over the boiler shell top. Tar paper was placed on top of the block layers to catch drips from the mortar on the bricks. The fire bricks were laid on top of the blocks. After the mortar hardened, the blocks were set afire and the air space burned out. A blower taken off a forge was used to force in air and blow out the cinders.

Salem, Mass. G. F. HARDEN

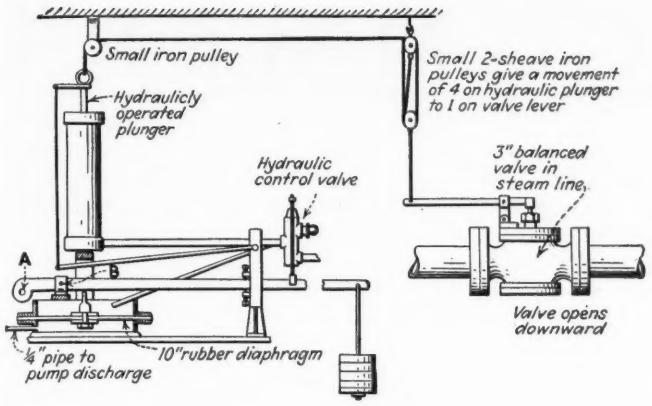
Greenish Growths in Cooling Water Prevented

IN COOLING water ponds and the tanks of cooling towers, a greenish growth sometimes occurs. This can be prevented by adding potassium permanganate to the water. One pound of this material dissolved in water is sufficient to treat 1,600 cu.ft. of cooling water. When first added it will turn the cooling water a violet color, which will soon disappear. The treatment will not be harmful to metal parts with which the water comes in contact.

Herts, England W. E. WARNER.

Change in Regulator Solves Pump Control Problem

HOW A troublesome speed variation of a turbine-driven centrifugal pump was cured may be of interest. The pump supplies cooling water to a barometric condenser serving a 2,000-kw. turbine. The turbine is equipped


Small iron pulley
Hydraulicly operated plunger
Hydraulic control valve
Small 2-sheave iron pulleys give a movement of 4 on hydraulic plunger to 1 on valve lever
3" balanced valve in steam line
Valve opens downward
A
B
¼" pipe to pump discharge
10" rubber diaphragm

with a speed governor and a discharge-pressure control, the latter consisting of a standard damper regulator having a 10-in. diaphragm on which the pump pressure acts and which is counterbalanced by the usual lever and weights, as in the figure. To reduce the weight required to counterbalance the pressure on the diaphragm, pivot point *A* of the fixed end of the lever was moved toward the fulcrum to *B* about 3.5 in. This allowed us to reduce the counterbalance weight more than one-half, with a corresponding decrease in inertia. The regulator is connected to a balanced valve several feet from the throttle valve in the steam line.

Power demands when creating the vacuum require the full capacity of the balanced valve, but when the vacuum is established a constant discharge pressure of only 10 lb. is necessary. For the latter condition the balanced valve supplying steam to the turbine is open only a small amount. As a result, slight movement of the valve causes a comparatively large turbine-speed change, with a resulting change in discharge pressure.

A 2-lb. variation in discharge pressure of the pump was as close regulation as could be secured. The slow movement of the hydraulic plunger of the regulator permitted hunting to occur, causing a disagreeable change in the tone of the turbine. It was felt that if the ratio of travel between the hydraulic plunger and the balanced-valve lever could be increased, it would aid in smoothing out the turbine speed change.

A pair of small iron pulley blocks having two sheaves each were obtained and connected by a flexible wire cable to the regulator, as in the diagram. This arrangement gave a movement of 4 to 1 between the plunger and the balanced-valve lever and cured the trouble.

Discharge pressure at the pump remains constant at 10 lb., with a suction-lift variation of 10 to 12 ft. on the pump, and the disagreeable tone change of the turbine is eliminated. When the pump is connected to the regulator after picking up the vacuum, speed and pressure gradually drop to the desired point smoothly and without overtraveling the low point.

No. Plymouth, Mass. C. B. HUDSON.

Gas Engine Cranked by Water Turbine

A 50-HP. gas engine, direct connected to a 250-volt, 3-wire direct-current generator is installed in the new court house at Reading, Pa. It is started by an 8-hp. water turbine. This generating set furnishes emergency electric light for corridors and stairways in the building in case normal power fails.

When normal electric power fails, a solenoid releases a pilot valve that causes a plunger valve to open, admitting water to the turbine. The water turbine is of the francis type and operates at 3,600 r.p.m. under an effective head of 275 ft. Water is supplied from 25,000-gal. tanks on the roof of the building. For part of the distance up through the building the water main is 6 in. in diameter, and the remainder is 4 in. in diameter.

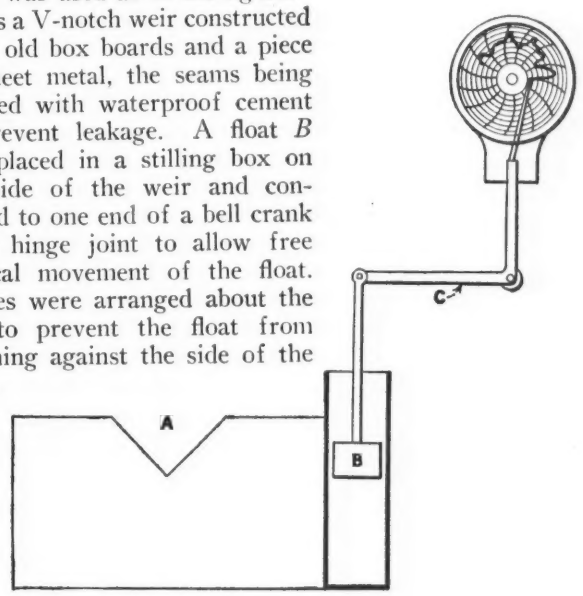
The turbine is connected to the crankshaft of the engine through a 32-deg. worm drive with a free-wheeling clutch so that the engine is automatically disconnected as soon as its speed exceeds the cranking speed. A system of relays controls the gas valve on the supply line to the engine, automatically opening them when normal current fails and closing them when normal alternating-current supply returns. The emergency power supply is available within 3 to 4 sec. after a power failure.

York, Pa. J. S. CARPENTER.

Recording V-Notch Meter Made From Discarded Material

IT WAS desired to know the amount of water wasted through a discharge line in order to determine whether or not it would be profitable to divert this water to the feed-water heater. The line was rather inaccessible, but to obtain a record of the amount of water flowing a recording meter was improvised. Having available in the plant parts of several old recording meters, one of them was used as in the figure.

A is a V-notch weir constructed from old box boards and a piece of sheet metal, the seams being caulked with waterproof cement to prevent leakage. A float *B* was placed in a stilling box on the side of the weir and connected to one end of a bell crank by a hinge joint to allow free vertical movement of the float. Guides were arranged about the rod to prevent the float from jamming against the side of the weir.



The bell-crank *C* was arranged to pivot about a fixed point below the meter casing and to its upper end was fastened a pen arm such as is used in recording instruments. The pen rested on a circular chart which was turned by a clock mechanism. The bell-crank was so proportioned that when the water level raised the float to the top of the V-notch maximum deflection on the chart was obtained, the zero reading being at the point where the water was just level with the apex of the vee. The chart was calibrated in inches by means of a hook gage. This apparatus worked very satisfactorily, and from the readings obtained the amount of water flowing through the line was determined for different periods of the day.

Bellerose, N. Y. HENRY C. OATLEY.

CURRENT COMMENT

Gas Explosions in Boiler Furnaces

SUCH gas furnace explosions, as reported in the March issue of *Power,* are particularly regrettable, since they are almost always avoidable if the person in direct charge will take proper precautions. That these preventable accidents occur with more or less regularity is evidence that the handling of gas is not sufficiently well understood, and that the dangers attendant on such occasions are either overlooked or regarded too lightly.

When lighting up a furnace using gas or oil, such precautions should be adopted that, in the event of a mishap, the resulting explosition will be minimized to the greatest extent, so converting what might have been a violent explosion into a harmless flame propagation, with a resultant "puff" incapable of doing any appreciable damage. In handling gas or oil around a furnace, never take a chance or trust to luck.

There is no set of rules that can be laid down covering all conditions, as each case varies. There is a cause for every explosion. It may be a small leak, which in a closed setting would gradually create an explosive mixture, awaiting only the entrance of a pilot light. In a cold setting, too quick opening of the valve after gas has been lighted sometimes causes the flame to recede to the rear of the setting, and as the gas is again diluted it flashes back with explosive effect. Explosions with oil have occurred when, on turning oil into a supposedly cold furnace, the vapor has been ignited by fire or red hot ash in the setting.

Before lighting a gas fire in a boiler setting there are a few precautions that should be observed. Open all accessible cleanout or observation doors, especially at the sides and upper part of the setting. Do not depend on a small piece of waste on the end of a stick to light the gas or oil; have plenty of good fire, and have it directly in the path of the entering gas. Turn on the gas slowly and let the immediate surroundings of the burner warm up before increasing the flow to full volume. After the gas or oil has been ignited, do not create a sudden increase in draft until some portion of the setting has heated up sufficiently to insure relighting of the gas, in case of some unexpected interruption in flow. Momentary interruptions to gas flow are generally caused by accumulation of water at some point in the piping system.

Probably the most frequent cause of accident, when lighting up furnaces, is the use of a small torch or piece of waste on the end of a wire, which is withdrawn as soon as the gas is lighted. If for some reason the flame is extinguished, there is an immediate rush to light it again. The man at the gas valve will probably be unable to shut it off quickly enough, or perhaps, not being schooled in the necessity for doing so, does not shut it off at all. The newly lighted torch is thrust through a door or port in the setting, now completely filled with gas, and an explosion occurs. Lighting a gas-fired boiler in this manner is taking a long chance that is decidedly not worth while. A shovel or two of live coal, an armful of oily waste, or a bundle of dry wood, should be so placed that the flame from it will be directly in the path of the incoming gas. Do not rush the job, make sure of each step, and give adequate thought to each possible contingency.

Chicago, Ill. S. M. QUINN.

Advances in Design of Propeller Turbines

YOUR editorial, "Propeller Hydro Units for Higher Heads," (*Power,* Nov., 1932) may have a misleading effect, at least upon those readers who are not especially acquainted with the subject. When discussing the application of propeller turbines it is essential that not only the operating head be cited but also the characteristics, such as horsepower rating, the conventionally recognized specific speed and physical size. The designer of turbines knows that propellers can be designed for specific speeds varying over 100 per cent and that the higher value applies to propellers operating under low heads, the lower values of specific speed being selected as the operating head increases.

Another feature not to be overlooked is that the size of the unit sets a limit not only on specific speed, but also on the operating head. The question of runner location above or below tailwater and the barometric pressure prevailing at the site of the plant is another feature of these installations.

All these factors are intimately interwoven as to their effect upon the ultimate commercial results. A disregard of the factors, either by reason of sales pressure or by lack of experience, has contributed to most of the troubles experienced with propeller plants. Your magazine deserves commendation for spurring the engineers in the progress of this art of designing turbines, however, only as long as its character is such that the effect is not ultimately more negative than positive, as regards commercial success of a plant.

Milwaukee, Wis. ARNOLD PFAU.

Steam Trap Maintenance

REPLIES to C. H. R.'s question in the February number emphasized the importance of maintaining traps in good condition; therefore some of our own experience may be of interest.

Vacuum pumps became steam bound, and after installing thermometers on the return lines just ahead of the pump receiving tanks, the water temperatures were frequently found to reach 190 deg. The thermal traps in particular were examined, and while they all appeared in good condition, the return water continued hot with occasional water hammer sounds where steam was blowing through.

As the traps were of numerous makes and sizes, it was almost impossible to test them individually on open-end lines, and touching the lines only revealed that they were hot. An aircraft engine temperature indicator was secured with a blind rivet thermo-couple, the rivet being

cut off flush and the couple secured to an ordinary frame clamp. With this device, clamped to the return line just beyond a trap the pipe temperature was easily observed and used to indicate whether or not the trap was tight.

Traps with the thermal element intact and the valve and seat in good condition were often found to be blowing steam, but by slightly unscrewing the valve from the thermal element, the traps would operate satisfactorily.

Altoona, Pa. A. R. MARKLAND.

Welded Piping, Pro and Con

SOME of the statements made in the discussions of welding fittings in the Current Comment (March number of *Power*) should not go unchallenged.

In the comment of Mr. Popp, it is inferred that pipefitters are responsible for the scrap left when a job is finished. Permit me to say that restrictions of specifications and the lump-sum method of payment are responsible for more scrap than is generally conceded to them. The mere fact that the scrap is near the pipefitter's bench is no reflection on the fitter's ability, unless the man is known to be a poor mechanic.

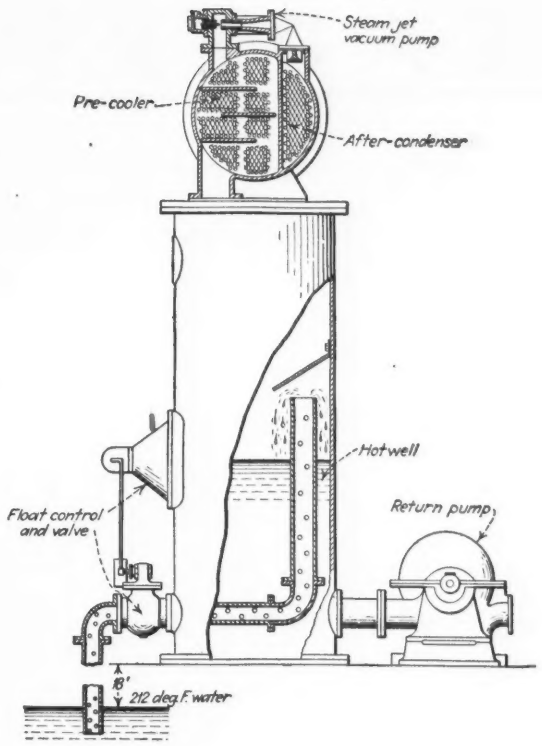
Further in Mr. Popp's comment he infers that parallel runs of piping cannot be nested close together on account of the torch room necessary. If Mr. Popp will visit runs of piping in close quarters, he will see that piping can be nested with welded fittings so that they almost touch each other. This is possible by temporarily taking the pipe out of place, welding the joints and then dropping the run of pipe back into place. Later the easy joints are worked to complete the run. This method has various modifications, and considerable ingenuity is exhibited by fitters and welders in this type of installation.

In the comment of Mr. Thornberry, he states that one 4-in. cut, one thread and one ream may be made in less than one minute. It does not seem possible that the three mentioned operations can be completed in such a short space of time. I have had fast machines, but none that turned the work out with this speed. Perhaps some interested reader will venture an opinion. I also doubt that a 4-in. bevel cut can be produced on this machine for the cost of less than 3 cents. It would seem to me that it would cost 3 cents to get the length of pipe from the rack or pile to the machine. Perhaps Mr. Thornberry did not consider this as a cost. I have found the cost of a 4-in. bevel cut to be about 30 cents.

Brooklyn, N. Y. WILLIAM ANDERSON.

Keeping a Pump Primed When Handling Hot Water

IN THE ARTICLE, "Vacuum Devices for Primary Centrifugal Pumps," in the April number, no mention was made of means to keep pumps prime that handle hot water. The temperature of the water places definite limits on suction conditions under which pumps can operate. For example, the dynamic suction lift on a centrifugal pump handling 100 deg. F. water is limited to 20 ft. With water at 212 deg. in an open tank, the center line of a centrifugal pump should be located about 15 ft. below the surface level of the water supply, so that not less than 12 ft. static head will be maintained on the pump suction at all times. Specially designed hot-well pumps are available that will handle water at critical temperatures with only 2-ft. suction submergence.



The diagram shows a method of keeping a centrifugal pump primed when it is located 18 ft. above the surface of 212-deg. water. The assembly consists of a receiving tank and a steam-jet air pump equipped with a precooler and after condenser. A float valve may or may not be used, depending upon operating conditions. A centrifugal or other type of pump is connected near the bottom of the tank.

To start operation, the steam-jet air pump is put into service, creating a partial vacuum in the receiving tank and the riser pipe. The partial vacuum in the riser pipe causes some of the water to flash into steam. Vaporization cools the water in the riser sufficiently to permit the vacuum to lift it in the pipe. This operation is further assisted by the air-lift effect of the steam bubbles in the water column in the pipe. As a result of this effect the water flows into the receiving tank before the vacuum alone is sufficient to cause it to flow into the tank.

The steam flashed from the water is condensed in the precooler and the non-condensables are removed by the jet so that the vacuum is maintained. The heat of the vapor condensed may be recovered by having plant makeup water pass through the precooler.

This system is suitable for use with filters, vacuum heating systems, flat boxes, suction rolls, and other services dealing with large volumes of air and vapor. There are also many applications where hot water must be raised several feet from a hotwell to the pump.

A somewhat simpler arrangement than that shown in the diagram is used where the liquid is comparatively cool and does not tend to flash into steam under the vacuum required to lift it. In this case the precooler and after condenser are not used and the steam-jet vacuum pump is mounted directly on top of the receiving tank.

J. C. GLENN,

New York City. *Foster-Wheeler Corporation.*

READERS' PROBLEMS

USING 25-CYCLE TRANSFORMERS ON A 60-CYCLE LINE—*We have three 25-cycle transformers that I would like to use as spares for those operating on 60 cycles. Would there be any objection to doing this?*

J. MCK.

In so far as the transformers are concerned, they may be operated on 60 cycles. The 25-cycle transformers cannot be grouped with 60-cycle transformers in a bank and operate satisfactorily. A 25-cycle transformer connected in parallel with a 60-cycle transformer of the same capacity would divide the load about in proportion of 25 to 60. That is, when the 60-cycle transformer takes a 60-kva. load, the 25-cycle transformer will supply about 25 kva. This proportion will vary somewhat depending on the design characteristics of the transformers.

On 60 cycles the iron losses of the 25-cycle transformer will be less, its reactance will increase, and the copper losses will be about the same as on 25 cycles. At 100 per cent power factor, the secondary volts will be about the same on either frequency. As the power factor decreases to lagging, the secondary volts of the transformer will decrease faster on 60-cycle than on 25-cycle operation.

SHAPE OF RECIPROCATING PUMP AIR CHAMBERS—*Why are pump air chambers usually made smaller at the bottom than at the top? It would be expected that they should be the same size of the pump outlet for their entire length. Is that true?*

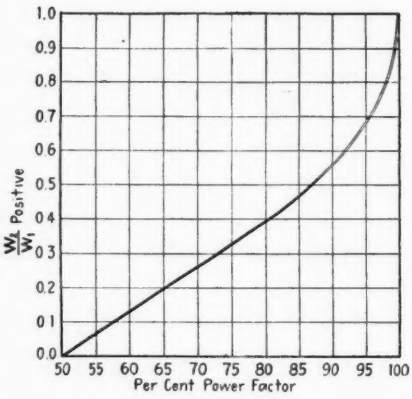
C. A. A.

For the air chamber to give a maximum cushioning effect, its water connection should be the same size as the discharge of the pump. The chief object in making the air chamber larger than its water connection is to provide sufficient air space in a container of convenient proportions. Cylindrical, spherical and pear-shaped chambers are used, not because they produce any better cushioning effects, but because they meet the requirements of sufficient air space in a compact design.

EFFECT OF POWER FACTOR ON SINGLE-PHASE WATTMETERS—When using two *single-phase wattmeters to measure power and power factor on a 3-phase circuit, would the meter readings be adversely affected if power were received at a low-power factor?* H. B.

The power factor of a medium-voltage power line is determined by the loads connected to it and not by any condition in the line. That is, the line does not supply power at a low or a high power factor, as intimated in the question. If the power factor of a load on a line is low, it is because of the low-power-factor loads connected to it.

Where 3-phase power is measured by two single-phase meters at power factors less than 100 per cent, the reading of one meter will increase and that of the other decreased until at 50 per cent power factor one meter will stop. Under these conditions the sum of the meter readings gives the total power transmitted in the circuit. Below 50 per cent power factor, one of the meters will reverse and the difference in the readings gives the amount of power supplied.



The power factor of the load is determined by the formula:

$$Tan.\ \theta = \sqrt{3}\,\frac{W_1 - W_2}{W_1 + W_2}$$

where θ is the angle of lag or lead of the current, the cosine of which is the power factor; W_1 the larger reading and W_2 the smaller reading of the wattmeters. W_2 maybe either positive or negative, depending on whether the power factor is greater or less than 50 per cent.

The curve gives the power factors for all positive values of $\frac{W_2}{W_1}$ and will cover conditions generally met with in practice. Assume that the readings of the wattmeters are positive and that one is 500 kw. and the other 300 kw. Then $W_2 \div W_1 = 300 \div 500 = 0.6$. Referring to the curves, it will be found that this value corresponds to a power factor of 92 per cent.

DIESEL-GENERATOR SET—*Is it practical to install a diesel to drive a 40-kw., 120-volt d.c. generator, either by flat or multiple-V-belt drive on the present flywheel? Will voltage regulation be as good as with the present steam engine? Will it be necessary to put in a new shaft? Is a 60-hp. diesel large enough?* H. H. B.

We assume you have a steam engine direct-connected to the generator and propose simply to disconnect the engine connecting rod and belt the diesel to the old engine flywheel. With such a combination, voltage regulation should be better than it is with the present steam engine, because of the added flywheel effect of the diesel. Even without that, however, the diesel will give as good voltage regulation. The crankshaft of the old steam engine will, however, probably be out of balance when the connecting rod is taken off. An easy way to check this is to rig up a motor so that it can be belted to the generator. Then bring the generator up to speed and see if the shaft is badly balanced. If it is it will, of course, have to be changed.

Either flat or multiple-V-belt drive will be satisfactory. You might also consider a direct-connected engine-generator set-up. We assume. of course, that you have checked the flywheel sizes and relative speeds of the proposed diesel and of the generator, and have found them satisfactory. The 60-hp. diesel will be of the proper size to drive the generator.

DIFFERENCES IN CYLINDER OILS—*Is there any difference between a steam refined and a filtered steam-engine cylinder stock?*

C. T.

The following answer to this question was given by James I. Clower, assistant professor of mechanical engineering, Virginia Polytechnic Institute, Blacksburg, Va.:

Differences exist between a steam refined and a filtered cylinder stock. Some of these are slight and influence the effectiveness of lubrication but little. Others. however, are of greater importance as they have a marked effect on lubrication under certain conditions.

Steam refining is used to increase the yield of lubricating oil and to minimize cracking. In the common fire still, cracking or decomposition of the oil molecules begins at 575 deg. F. or above, depending upon the characteristics of the crude. The introduction of live superheated steam directly into the body of the oil near the bottom of the still agitates and prevents overheating of the oil. Without this agitation, the oil adjacent to the bottom of the still might overheat and decompose. In water, convection currents are readily and quickly set up, but not in oil.

The most important result of using steam, however, is to lower the boiling point of the oil, thereby assisting in removing the vapors from the still to the condenser at a relatively low temperature. The distillation temperature resulting from this practice is 75 to 125 deg. F. lower than that necessary without steam.

Filtering is the process of removing color and deleterious compounds from lubricating oils by percolation over finely divided material such as fullers' earth, bone char, special clays, etc. The actual discoloration of oil is a process of absorption. The porous particles of the filtering material exert an attraction for the molecules of the oil. Unsaturated compounds develop greater attraction and the paraffin and napthene hydrocarbons are least attractive.

The process is thus a selective one and the very color forming, resinous and asphaltic bodies that are undesirable are the ones that are most susceptible to absorption and hence are removed. The cohesion of the oil is largely dependent upon these substances, hence their removal renders the oil less cohesive, thus making it more susceptible to atomization. For this reason, it is possible to feed smaller drops which atomize quickly upon reaching the quill of the atomizer in the steam line.

Because of their improved atomizing characteristics, filtered oils are generally used where the feed is direct to the cylinder and valves, as non-filtered oil will not atomize sufficiently to provide adequate distribution. In general, however, filtered oils will not adhere to moist cylinder walls as well as the non-filtered oils.

How Wabble in Belts Can Be Stopped

Answers to April Question 1

THE QUESTION

WE HAVE a number of belts that have developed a tendency to wabble across the faces of their pulleys. These belts appear to be in good condition, but I have been unable to make them run true. We have other belts operating under approximately similar conditions that do not wabble. Probably some readers can give their experiences with correcting such belt troubles. B. H.

Eight Causes of Belt Wabble

THE following are the more common causes for the belt troubles experienced by B. H.:

1. Sticky preparations or dressings have formed a hard, lumpy surface on the contact side of the belt.
2. Pulleys are out of alignment.
3. Belt joints were improperly or carelessly made and now demand attention.
4. Atmospheric effects and other local plant conditions, such as moisture, dirt, grit, soot, acid fumes.
5. Belts have never been lubricated.
6. Insufficient belt tension.
7. Belt is overloaded.
8. Pulleys are too small for the belt used.

Although other belts that operate under similar conditions do not wabble, this does not insure against future trouble, but merely indicates that these belts have not reached the trouble point.

Since the belts that have a tendency to wabble are in good condition, it would indicate that the cause is misalignment. This feature requires checking at intervals, as it is practically impossible to have the pulleys remain in alignment.

West New York, N. J.
KERMIT B. HOFFMAN.

Faulty Pulley Construction Cause of the Trouble

I HAVE corrected on several occasions belts that wabbled across the face of the pulley. The fault was always found to be one of two defects in the pulley. In some cases the crown of the pulley was not machined centrally with the other parts. On other pulleys, crowns were in the center but pulley diameters at the two outer edges were not the same.

Duboistown, Pa. ERNEST H. SHORE.

Reducing Belt Tension Stopped Wabbling

WABBLING of belts generally indicates underload, misalignment of pulley or overload. First, make sure the pulleys are in alignment.

There are several ways of correcting wabble due to underload: Reduce the speed of the belt by installing smaller pulleys of the same ratio as the original ones. The best belt speeds are from 3,000 to 5,000 ft. per min. If the belt is double-ply, the wabble, if caused by underload, may be corrected by using a single-ply belt or a narrower one.

In case of overload, the condition can be corrected by increasing the speed of the belt, within the limits previously mentioned, or by substituting a heavier or wider belt.

If the slack side of the belt is on top, which is preferable, the belt may have so much tension that it cannot wrap around the smaller pulley properly. This is a condition that I found on one drive where the belt gave trouble by wabbling, and would come off the pulleys when a load was applied. The fault was corrected by reducing the tension in the belt to give it more slack.

Milwaukee, Wis. L. M. LARSON.

Uneven Stretch May Cause the Trouble

A BELT that does not run straight, or wabbles, may have been unevenly stretched when placed on the pulleys. This often occurs when the belt is cut a little too short and has to be forced on the pulley, which causes a crook or pull-out on one side. A belt made from inferior leather will stretch unevenly, resulting in a zig-zag track on the pulley face. Sometimes the shaft is sprung from undue tension, causing the pulley to rotate unevenly. A line-up of the pulleys will discover that trouble.

If the fault is in the belt, the best remedy is to return it to the manufacturer, to be taken apart, straightened and re-cemented.

ERNEST L. BALDWIN, *Pres.*
Baldwin Belting & Leather Co., Inc.
New York City.

Belts Not Straight; This Causes Them to Wabble

APPARENTLY the belt is not straight, and this is the cause of wabbling. I have corrected troubles of this kind by opening the belt at one of its joints, laying it on the floor, and then checking it for straightness. Occasionally a belt will stretch more on one edge than on the other, leaving to the belt man the choice of sending it back to the manufacturer (which is often the wiser plan) or working it over, which is usually a tedious and futile method unless one is an expert at repairing belts.

About the best way to straighten a single-ply belt is to cut it in several pieces, turn half of the pieces end for end, and then reglue them in this position. One must make up for some loss in fitting the laps, and often the belt will have loose edges, but it will still be a fairly good belt reconstructed out of a crippled one.

Two-ply belts are less likely to become crooked, especially when they are properly made. However when they do become crooked, I would suggest splitting the plies apart and turning one ply end-about before regluing in the same manner as suggested above. This treatment will seldom fail to straighten any belt. In the foregoing it is assumed that the fault is not in the pulleys.

Atlantic Highlands, N. J.
M. M. GOOCH.

Unequal Tension in Belt May Cause Trouble

WHEN endeavoring to locate the cause of the trouble, first check the pulley shafts to see that they do not have excessive end play. It is usual practice to allow about $\frac{1}{16}$ in. between one collar and the bearing block. If the shafts and pulley are correct mechanically, the fault must be in the belt.

It sometimes happens that the tension in the two edges of a canvas belt are not equal, due to maladjustment of the loom on which the fabric was made or because of unequal pressure on the rubber when curing. Such belts will often run to one side and even run off flat-faced pulleys. This fault usually can be remedied by reversing the belt end for end. A crowned-faced pulley tends to hold the belt in line, but like every good thing can be overdone, particularly with rubber belts having many plies.

Where belts are not endless, rawhide lacing has an advantage over metal fastenings in that it tends to equalize any inequalities of tension in the two edges of the belt. If the ends are not cut square, metal lacing will frequently produce a wabble which eventually causes the fastener to tear out the tight edge of the belt.

St. Louis, Mo. L. R. BAKER.

Two Questions for Our Readers

Question 1

WE OPERATE a 120-ton refrigerating system using CO_2 as the refrigerant. During the summer the available condensing water averages about 80 deg. F., resulting in high head pressure and a corresponding increase in power required to operate the compressors for the same refrigerating effect. It has been suggested that some of our refrigerating capacity be used to cool the condenser circulating water and so reduce the head pressure. Would such a scheme secure any saving in power required per ton of useful refrigeration? L.R.M.

Question 2

WE HAVE two 8,000-sq. ft., sectional-header boilers in our plant. They are fired by underfeed stokers. The furnace volume is about 1,600 cu. ft. and can obtain a maximum rating of about 200 per cent. We are considering changing over to oil burners and want to know what changes should be made to the setting. Should the stoker be removed, and can we expect to obtain increased output with oil fuel?

W. MCW.

Suitable answers from readers will be paid for if space is available for their publication.

Rolls Belt to Make It Straight

THE belt trouble experienced by B. H. is not uncommon. To correct the fault, check the pulleys and shafting for alignment. Note if the speed is constant, as sometimes pulsating speed will cause a belt to wabble. Check up on the belt to see that it is of the proper width and thickness for the speed and load and also see if the joints are properly made.

To check the belt for straightness, open it at one joint and run it through a pair of metal rolls such as a tinsmith uses, the rolls being set moderately tight on the belt. If the belt does not come out straight, turn it over and run it through the rolls again. This treatment will tend to make the belt of uniform thickness and also make it straight.

A belt properly made from good material and correctly treated will not wabble; at least this has been my experience.

Toronto, Ont. JAMES E. NOBLE.

Size of Conductors for Three-Phase Motor Load

Answers to April Question 2

THE QUESTION

I EXPECT in the near future to be called upon to design a power line 1,200 ft. long to supply a load of nine 3-phase alternating-current motors totaling 870 hp. The power will be transmitted at 2,300 volts, 60-cycles, and stepped down through transformers to 440 volts for the motors. What size conductor will be required for the 2,300-volt line when installed in the open on insulators? Power factor will be about unity, as the load is about equally divided between synchronous and induction motors. Although the motors will all be operated at the same time, it is doubtful if they will all be fully loaded. In the design of a line of this kind, is allowance made for diversity factor of the load? C.A.A.

Bases Size of Wire on National Electrical Code

I WOULD suggest that on such a short line operated at the voltage given, that the table for size of wire in the Underwriters Code be used to determine the size of the line conductors. Watts at 100 per cent diversity factor is found by the formula:

Watts = 746 Hp. = 746 × 870 = 649,020

At unity power factor the current per wire in a 3-phase system is

$$= \frac{\text{Watts}}{1.73 \times \text{Volts} \times \text{Power Factor}}$$

$$= \frac{649{,}020}{1.73 \times 2{,}300 \times 1} = 163 \text{ amp.}$$

In the National Electrical Code wire table it will be found that a No. 0 weather-proof wire will carry 200 amp. and a No. 1 will carry 150 amp. A No. 1 wire would carry the load because the motors are not all fully loaded, but to be on the safe side and allow some provision for starting, it would be good practice to use the No. 0 wire.

It is customary to take into consideration the spacing factor. Presume that the wires are in a horizontal plane and have an effective spacing of 24 in. The resistance of a No. 0 hard-drawn wire is 0.1 ohm per 1,000 ft., or 0.12 ohm for 1,200 ft. Then, the volts drop per wire equals resistance in ohms times the current in amperes, equals 0.12 × 163 = 19.56, say 20 volts. To obtain the reactance drop per wire with a 24-in. effective spacing, refer to a reactance table and it will be found that a No. 0 wire will have 0.12 reactance-volts drop per ampere per 1,000 ft. of conductor at 60 cycles, or 0.144 reactance-volts drop for 1,200 ft. Then the total reactance-volts drop is 0.144 × 163 = 23.47, say 24 volts drop.

The volts drop per wire is $Ed = \sqrt{E_r^2 + E_x^2}$, where E_r^2 equals resistance volts drop, and E_x^2 equals the reactance volts drop. Then the volts drop $Ed = \sqrt{20^2 + 24^2} = 31$ volts. The line drop is equal to 1.732 times the volts drop per conductor, equals 1.732 × 31 = 54 volts. This is a 2.4 per cent drop, and on motor loads a 5 to 10 per cent drop is generally allowed. It would probably be safe to use a No. 1 wire for this line. But in the future, there may be a demand for more load, therefore it is advisable to use the No. 0 wire.

Birmingham, Ala. GRADY H. EMERSON.

Would Neglect the Diversity Factor

ASSUMING a combined motor and transformer efficiency of 86 per cent, the load to be transmitted will equal 870 × 0.746 ÷ 0.86 = 753 kw. The current I = (753 × 1,000) ÷ (1.732 × 2,300) = 189 amp. According to the National Electrical Code wire table, the smallest size Class C insulated wire that can be used for this load is a No. 0, which has a carrying capacity of 200 amp.

Figuring the loss for this size wire, $W = I^2 R$ = 189 × 189 × .098 × 1.2 = 4,200 watts for one conductor and for the three conductors the loss will be 4,200 × 3 ÷ 1,000 = 12.6 kw. This is equivalent to a loss of 12.6 ÷ (753 + 12.6) 0.0164 or 1.6 per cent. The diversity factor for this sort of load will likely be about 80 per cent. Ordinarily it would be best not to take the diversity factor into consideration but allow this margin to take care of the additional load that will probably occur in the future.

Two Rivers, Wis. HOWARD G. PLANK.

Prefers Load Factor to Diversity Factor

IT IS easier to solve this problem with the load factors of each motor than to use the diversity factor of the group of motors as a whole. Individual load factors are easily obtained and they can be used in any combination of loads. On the other hand, the diversity factor varies with each installation. The load factor, as used here, is the ratio of the average power taken by a motor to the rated power of the motor.

Load factors given below are for typical loads, have been determined by actual tests in a large steel mill, and are those used to determine line sizes. This plant transmits 3-phase, 25-cycle power at 2,300 volts and transforms it to 440 volts for motors, a condition similar to the one in the problem. Using these known load factors and assuming the number and the size of individual motors (data not given in the problem) the size of the 2,300-volt line would be determined as follows:

Motors No.	Motors Hp.	Kind of Load	Load Factor	Amps
2	100	Centrif. pumps.....	0.95	36
4	50	Ventil. fans.....	0.43	16
2	85	Air compr.....	0.80	26
1	300	D.-c. gen.....	0.75	42
9	870	Total.....		120

The first two classes of loads are usually driven by induction motors and the last two generally have synchronous motors. This fulfills the condition of the problem that the total load is about equally divided between these two classes. The power factor of the load is taken as unity as given in the problem.

No. 2, Class C insulated wire is rated at 125 amp. and will, therefore, carry the load. The line current with the worst condition—all motors except one operating and that one starting—should not be more than 200 amp. No. 2 wire has 0.156 ohm resistance per 1,000 ft. and 1,200 ft. of wire will have a resistance of 0.156 × 1.2 = 0.187 ohm. Then the volts drop per line will be 0.187 × 200 = 37.4 volts and the total line drop will be 37.4 × 1.732 = 65 volts, a reasonable value.

Hammond, Ind. S. EIN.

Carry-Capacity Determines Size of Conductors

ANY line must be designed with three factors in mind: Maximum load, voltage drop at maximum load, and energy loss (usually considered on an annual basis).

Consider the first two factors together. Since no maximum load is given, it is assumed that the maximum load will be 1 kva. per motor horsepower. On this basis, with 2,300 volts delivered at the receiving end, the current will be practically 220 amp. per line, assuming unity power factor.

The conductor size, for weather-proof insulated conductor, would be not less than No. 00 copper without any consideration to line drop. If it is assumed that the three conductors are placed on one cross-arm in a horizontal plane, the drop at the assumed load with spacing of 14 and 28 in. will be approximately 36 volts to neutral or 1.6 per cent. It is at once evident that carrying capacity rather than volts drop is the governing factor.

No allowance can be made for diversity factor unless definite information is available concerning the number of motors installed with their capacities and their load cycles. In any event the size of conductor would have to be based on the actual load rather than volts drop in the line.

C. O. VON DANNENBERG.

Brooklyn, N. Y.

THE ENGINEER'S BOOKSHELF

Five-Place Tables

McGRAW-HILL FIVE-PLACE LOGARITHMIC AND TRIGONOMETRIC TABLES (1933). *Prepared under supervision of Ralph D. Beetle, professor of mathematics, Dartmouth College. Published by the McGraw-Hill Book Co., 330 West 42d St., New York, N. Y. One of the McGraw-Hill Series of Texts on Mathematics. Clothboard covers. 131 pages, 5x8 in. Price $0.80.*

Simple, convenient, and unusually legible tables, arranged in order of greatest usage, comprise this volume. Included is a table of factorials and primes, not ordinarily included in such compilations. Tables are: Common Logarithms of Numbers, Important Constants and their Logarithms, Common Logarithms of Trigonometric Functions, Powers and Roots, etc., Conversion of Degrees to Radians, Numerical Values of Trigonometric Functions, *N* Factorial and Prime Numbers, Directions for Use of the Tables. These tables are particularly useful in trigonometry, but the log tables and powers and roots will be found handy in solving many power problems.

Standards Yearbook

STANDARDS YEARBOOK, 1933. *Compiled by the Bureau of Standards, U. S. Department of Commerce and available from the Superintendent of Documents, Washington, D. C. Clothboard covers. 250 pages, 6x9 in. Indexed. Price $1.*

This seventh edition of the standardization annual outlines accomplishments and activities not only of Federal government, but also those of States and counties, and gives a resumé of the work of scientific and technical societies and trade associations. A brief account of international cooperation in standardization is followed by a summary of the activities of the national standards associations of the various countries. Its ten chapters inform the manufacturer of current standardization affecting his industry, give engineers and others an outline of current research leading toward standardization, and give sources of further information.

Numbers

NUMBER—THE LANGUAGE OF SCIENCE. (SECOND EDITION). *By Tobias Dantzig, Ph.D. Published by The Macmillan Company, 60 Fifth Ave., New York, N. Y. 262 pages, 6x8½ in. Clothboard covers. Indexed and Illustrated. Price $2.50.*

Engineers, including power engineers, deal with figures and numbers all day every day, and yet few of us realize that modern arithmetic is scarcely 400 years old. True, certain concepts of numbers have been known since the days of the Egyptians and earlier, but their modern application and use is a comparatively recent development. Further, it is not generally known that some South Sea Islanders cannot count beyond two or three, that some Africans limit their efforts to ten or twenty and that only few animals have any conception of number whatsoever.

It is obvious that this is a book that has but little direct practical application. But it is indirectly practical, amazingly interesting and well worth anyone's time to read and reread. It is authoritative information without technicality, popular writing without ballyhoo.

Job Salesmen

THE TECHNICAL MAN SELLS HIS SERVICES (1933). *By Edward Hurst. Published by McGraw-Hill Book Co., 330 West 42nd St., New York, N. Y. 239 pages, 5½x8 in. Clothboard covers. Price $2.*

Degrees, diplomas and letters from professors are little help for the technical graduate today; industry has more men than it needs and finds a summary "No" the readiest answer to ordinary requests for employment. In his necessity, the graduate must turn to more successful ways of selling himself to a prospective employer, and this book is designed to give him the weapons he needs. Written by a man who has a long record of success in advising and assisting graduates to get jobs, the book, in manuscript form, has already been used at M.I.T. with success.

There is no question of the efficacy of the methods Mr. Hurst propounds. He shows the college graduate that his biggest job is to show the employer that he can become a profit-making cog in the industrial machine, now so badly in need of just those cogs. No broad generalization, no flowing language, just a fairly good job of straightforward writing that illustrates by concrete examples, this book is probably the best of its kind that has been written. Just two little doubts assail this reviewer. The first is the feeling that some of the word pictures of job interviews are considerably overdrawn. In several instances men right out of college win jobs at $3,000 a year—in these times they would be lucky to get half that to start. In other instances, the amount of work done on his own by some enterprising student to win a particular job is little short of phenomenal—witness one young man who came to an interview armed with a microscope and 900—count 'em—900 slides. The other doubt is that most young graduates have enough initiative and "savvy" to figure out a similar sales attack for their own use. The author advocates industrial experience for college men before or during the period of their engineering course, and graduate students with this experience can of course work out solutions for troubles just as any other engineer would. But the average graduate will have to get a few good hard knocks before he will get down to work on the basis described by Mr. Hurst. Actually, this reviewer feels that the book has even a greater appeal to the engineer who has had industrial experience and now finds himself out of a job.

BRIEF REVIEWS

ADVANCE PLANNING OF PUBLIC WORKS IN THE DISTRICT OF COLUMBIA. *Published by the Federal Employment Stabilization Board and available from the Superintendent of Documents, Washington, D. C. 28 pages, 9x12 in. Price $0.10*—A general treatment, describing methods now being followed by the District of Columbia in planning public works six years ahead and showing how this may be applied to municipal administration.

IMPROVED WEATHER-RESISTANT COVERINGS FOR OVERHEAD LINE WIRES (1932). *By Carter, Olson, Harding, and Shreve. Published by the Engineering Experiment Station, Purdue University, Lafayette, Ind., as Research Bulletin No. 43. 71 pages, 6x9 in. Paper covers. Price $0.50*—Tabular and graphical results of an extensive series of tests determining major faults of these coverings (principally poor saturants) and suggesting new asphaltic materials for the coverings.

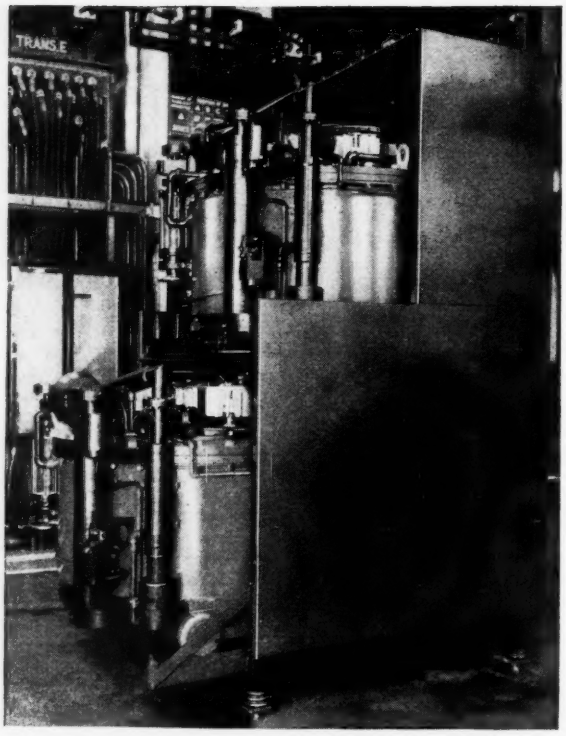
A METHOD OF DETERMINING VALUES OF DIFFERENT FUELS FOR POWER PLANT USE. *By H. M. Faust, research engineer. Engineering Experiment Station, Ohio State University. 8 pages, 6x9 in. Published by Ohio State University as Circular 29 of the Engineering Experiment Station. Free*—Of assistance to boiler plant owners and operators in making an accurate choice of fuel for their particular needs.

INVESTIGATIONS OF FUELS AND FUEL TESTING (1930 and 1931). *A 166-page, paper-bound report of investigations of the testing and research laboratories of the Canadian Department of Mines*—Included are four researches on solid fuels and five on natural gas and liquid fuels.

AN EXPERIMENTAL INVESTIGATION OF THE FRICTION OF SCREW THREADS (1933). *By Clarence W. Ham and David G. Ryan. Bulletin No. 247, Engineering Experiment Station; University of Illinois, Urbana. Price $0.35*—Primarily, this study investigated coefficient of friction of power screws. For screw threads of average quality of materials and workmanship, operating under ordinary conditions, the coefficient of running friction is 0.125, that for starting friction is 1½ times the coefficient of running friction. Coefficients of friction for plain collar thrust bearings used with power screws may be taken as the same as those of the screw.

WASHABILITY STUDIES OF THE BLUE CREEK BED AT THE CONNELLSVILLE MINE, CONNELLSVILLE, ALA. *By Gandrud, Richardson and Payne. Published by the Bureau of Mines, U. S. Department of Commerce, Washington, D. C. as R.I. 3200*—In mimeograph form.

WHAT IS WRONG WITH OUR PATENT SYSTEM? *By William A. Hamor, Mellon Institute of Industrial Research*—A reprint from *Industrial and Engineering Chemistry.*



Two-section, 250-volt, 750-kw. mercury rectifier

MERCURY-ARC RECTIFIERS

Used For 250-Volt D. C. Supply

By C. A. BUTCHER

Manager of Engineering, Northeastern District, Westinghouse Electric & Manufacturing Co.

Here are indicated the possibilities of using mercury-arc rectifiers for 250-volt power supply, with a comparison of the cost, reliability, efficiency, operation and maintenance of rectifiers, synchronous converters and motor-generator sets

ADVANCES in the quality and efficiency of mercury-arc rectifiers in the past few years appear to make this type of conversion equipment suitable for a considerable part of industrial applications requiring 250-volt direct current. Rectifiers will not immediately supplant converters and motor generators for all or even a large part of industrial applications. The present quality of the rectifier, however, justifies an investigation in most cases for ratings of 50 kw. and above, and for 250 volts and higher. There is also the promise of gains in efficiency and flexibility, and possibly lower cost.

The conversion of alternating current to direct current in large centrally located substations, together with low-voltage direct-current distribution even in heavily concentrated load centers is costly, and inefficient by comparison with alternating-current distribution. Even at the lower voltages this is evidenced by the rapid growth of the low-voltage alternating-current network system in many metropolitan areas. In a number of these, load is being transferred from the direct-current to the alternating-current network, preparatory to ultimate elimination of the direct-current network. In nearly every case, new load is to be taken only on the alternating system.

Consumer investment in direct-current apparatus, such as motors for elevators, pumps, blowers and for driving machinery, is large. In many instances this investment is so great as to constitute a barrier to a change over to the alternating-current system within a short period. It is to be expected that either the direct-current network must be retained at least in part, or provision made for conversion apparatus connected to the consumer's service to provide the necessary direct current.

To provide this direct-current capacity essential to avoid excessive investment in a change over from one system to the other, and still take advantage of the higher efficiency of alternating-current generation and distribution, conversion apparatus will be required. The type should be selected on its merits, considering first cost including installation, reliability, operating efficiency, operating cost and maintenance.

Complete equipment for a small rectifier installation for 250-volt direct-current supply will cost probably 50 per cent more than that for either a synchronous converter or a motor generator. But the higher cost of the rectifier may be largely offset by its lower installation cost. There is usually a space on the premises that may be utilized for a small substation. This space may be so located as to offer a serious problem in adequate ventilation for rotating apparatus; sound-proofing may be necessary to prevent complaints from noise-conscious tenants, and special foundations are required. Since these requirements are not necessary with rectifiers, their resultant lower installation cost may more than offset the additional cost of the equipment.

Experience indicates that mercury-arc rectifiers, in capacities of 1,000 kw. and less at 600 volts have, on the whole, records of service equal to those of other types of conversion apparatus. There is no reason to assume that in 250-volt service their reliability will be reduced.

The curves, which are for 300-kw., 250-volt conversion equipment supplied from 3-phase 60-cycle, 6,600-volt system, show that if the average load is less than 60 per cent of rated capacity the rectifier is more efficient than the synchronous converter. At 25 per cent load the rectifier has a favorable margin in efficiency of approximately 5 per cent over the synchronous converter. Even at full load, the rectifier has a favorable margin of 3 per cent over the motor generator. At 50 per cent load the rectifier's efficiency is better by 7 per cent, at one-quarter load by approximately 14 per cent. Idling losses of the rectifier are only approximately one-seventh of those for the motor generator, and less than one-third those of the synchronous converter.

Since the average load is often less than 50 per cent of a machine's rating, the rectifier may be expected to have an operating efficiency around 10 per cent better than a motor generator and at least equal to that of a synchronous converter in the same service. On an average load of 100 kw., and with energy at 2c. per kw.-hr., the saving by this margin of efficiency would be approximately $1,700 per year. This saving, capitalized at 15 per cent, represents an added inherent worth of over $11,000, which will cover any part of the increased first cost not compensated for by other gains.

Operating costs for completely automatic equipment would be approximately the same for all three types of conversion apparatus.

The cost of maintenance should be but a small percentage of total annual charges. In general, high maintenance cost for rectifiers results from trouble. Since there is nothing about a rectifier to wear out normally (as do current collecting parts of rotating machines) except from corrosion of the surfaces in contact with the cooling water, a reliable rectifier should have a lower maintenance cost than a rotating machine.

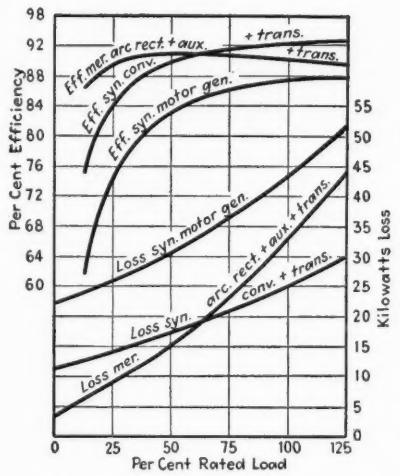
Service continuity demands a certain amount of space capacity. The usual requirements are that the maximum load shall be served when the largest unit of a group is out of service. On the average the number of units installed will be three of equal rating. For example, three 150-kw. motor-gen-

erator sets, of which only two are required to carry the load. This is good practice for rotating machines. With only one unit operating during light-load periods, and two units during maximum load, they are fairly efficient.

Since the rectifier has a fairly constant efficiency, it is apparent that there is little to be gained by using a small unit at light load. Assume a load to be supplied entirely from one automatically controlled 300-kw. rectifier. If an outage occurred the spare unit would be automatically put into operation with the lapse of only a few seconds.

Considering then an installation of two rectifiers, as against three motor generators or synchronous converters, the rectifier installation would have a total capacity one-third greater than the 3-unit layout. It would operate with higher over-all efficiency than motor generators, but would probably have no advantage over synchronous converters. The sectional arrangement of rectifiers applied in such a case makes for economy by providing readily for subdivision to reduce spare-capacity requirements.

The most efficient means of supplying the neutral to a three-wire direct-current service from a rectifier is to provide a two-unit direct-current generator. The two units are connected in series across the terminals of the rectifier, with the neutral tap made at the series connections. Since the load is ordinarily fairly well balanced, only a small-capacity set would be required. Since the neutral is necessary only for lighting circuits and the conversion losses may be saved by connecting the lighting to the alternating-current system, a direct-current neutral would not ordinarily be essential.



Efficiency and loss curves for 300-kw., 250-volt conversion direct-current equipment

Close voltage regulation is important only as a means of minimizing the flicker of lights. Voltage regulation such as of the order of 4 or 5 per cent, which is inherent to a rectifier equipment would ordinarily be quite satisfactory for power circuits. If close voltage regulation is needed, it may be had at some increase in cost in several different ways, but most probably by grid control of the rectifier.

Necessity for close voltage regulation of the alternating-current power supply may require that currents for starting large motors be limited to quite low increments. This results in an extension of starting time, and a material addition to the cost of control equipment. Since there is no inertia to be overcome in starting a rectifier, it may be put into service by connecting directly to the power supply.

Comparison 300-Kw., 250-Volt Conversion Equipment for Which the Curves Have Been Plotted

Average Per Cent Load, 8,600 Hr. per Yr.	Saving in Losses Kw.	Annual Saving Dollars at 2 c. per Kw.-Hr.	Kw.-Hr.	Equiv. Extra Value of Rectifier Capitalized at 15 Per Cent, Dollars
		Rectifier Vs. Motor Generator		
12.5	17.8	153,000	3,060	21,000
25	17.0	146,000	2,920	19,500
50	15.6	134,000	2,680	17,900
75	13.3	114,000	2,280	15,200
100	10.4	89,500	1,790	11,900
		Rectifier Vs. Syn. Converter		
12.5	6.7	57,600	1,152	7,680
25	5.2	44,700	894	5,950
50	2.2	18,900	378	2,520
75	—2.3	—19,800	—396	—2,640
100	—7.9	—68,000	—1,360	—9,060

Comparison of No-Load Losses

Motor generator	22.1 Kw.
Syn.-converter equipment	11.4 Kw.
Rectifier equipment	3.3 Kw.

Kaplan-Type Turbine for 106-Foot Head

Another unit is to be installed in the hydro-electric plant on the Shannon River in the Irish Free State. This plant which was contracted for in 1925, was designed for six 38,600-hp. units, under a 106-ft. head. Three of these have been put into operation, the turbines being of the francis type.

Contracts have recently been placed with Siemens Schuckart and Company of Berlin for the fourth unit. This company will handle the construction and electrical parts of the work, and J. M. Voith, Heidenheim will build the turbine.

For this unit the turbine will be of the adjustable-blade Kaplan type, rated at 38,600 hp. under a 106-ft. head. Because of the tide the head at the plant may be as low as 86.7 ft., the wheels being designed for 30,000 hp. under a 95-ft. head.

This head is the highest for which a Kaplan-type turbine has been designed. The highest head units of this type in operation in the United States are in the plant of the Safe Harbor Power Corporation, on the Susquehanna River. These units are rated at 42,500 hp. under a 55-ft. head. Two 12,500-hp. Kaplan turbines in the Mixnitz plant in Austria operate under a 65-ft. head. Three machines are under construction for the Wettingen station of the City of Zurich, Switzerland, that have a rating of 10,000 hp. under a 76-ft. head and two 18,400-hp. turbines of this type for a similar head are being built for the Groenvallfoss plant in Norway. The head at the two latter plants is 30 ft. less than the maximum under which the Shannon River Kaplan unit will operate. The runner blades for this unit will be made of stainless steel.

Smoke Rings Bell, Lights Sign, Records Time

The smokestack of the B. Altman store, Fifth Avenue, New York City, is in the midst of some overhanging apartment buildings, and it is desirable that no smoke offend the occupants. Accordingly a photoelectric relay unit has been put on guard, and if even a slight puff of smoke goes up the chimney, bells are rung in the two firerooms, a sign reading in big red letters "Smoke" lights in front of the desk of Chief Engineer Cummings, and the time and duration of the smoke is recorded on a curve-drawing galvanometer. From this last, at the end of the day, the graph-ribbon can be withdrawn and studied at leisure, showing just *when* smoke occurred, *how often,* and *how long* it lasted.

Factors in Business Recovery Outlined at Welding Meeting

The art of welding can make a definite contribution to general business recovery by making possible new and more desirable manufactured products. Moreover, the adaptability of the welding process will help keep manufacturers foot-loose to anticipate changed demands and incorporate new ideas. These were conclusions of Willard T. Chevalier, publishing director of *Engineering News-Record* and *Construction Methods,* who delivered one of the principal addresses at the annual meeting of the American Welding Society, at the Governor Clinton Hotel, New York City, April 27 and 28.

At the same meeting, Charles T. Abbott, executive director of the American Institute of Steel Construction, urged industry to take charge of its own affairs in order to avert the imposition of a super-control by the government.

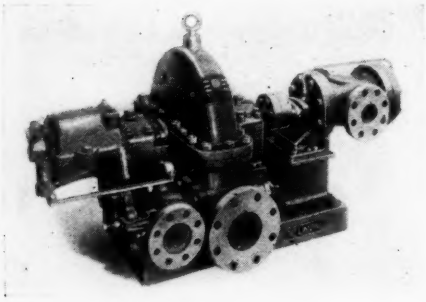
The meeting was a complete departure from previous national meetings in that most of the usual technical discussions were omitted, their place being taken by the two addresses already mentioned and by a lecture in which Prof. F. P. McKibben, re-elected president of the Society, broadly outlined the present status of welding in the erection of steel buildings and the strengthening of steel bridges.

A tentative code of fusion-welded pressure piping was presented by the committee chairman, T. W. Greene. This code, which awaits final approval by the A.W.S. and A.S.M.E., is being worked up for the American Standards Association. It is not intended to regulate best practice but rather to indicate the minimum safety requirements.

A tentative code on the use of welded steel parts for machinery construction was presented by G. D. Spackman, Chairman of the Committee.

The Samuel Miller Memorial Medal for outstanding service to the art of welding was presented to Herbert H. Moss, development engineer for the Linde Air Products Co. Officers elected for the ensuing year are: President, F. P. McKibben; Senior Vice-President, J. J. Crowe. Divisional Vice-Presidents: Pacific Coast, D. J. Williams; Southern Division, G. Raymond. Directors-at-Large: A. Vogel, W. H. Gibb, H. S. Smith, J. C. Lincoln and W. C. Swift.

WHAT'S NEW IN PLANT EQUIPMENT



Rotary Displacement Pumps for Oil Burners

These De Laval-IMO pumps provide constant pressure, and are adapted for either turbine or motor drive. With steam turbine drive, a pressure control device is fitted which gives smoothly variable speeds. Direct-coupled steam turbine-driven unit illustrated has, at 3,000 r.p.m., capacity of 150 g.p.m., against 160 lb. pressure when pumping light fuel oil of 35 to 55 SSU. at 100 deg. F. Turbine has constant speed governor, and also emergency overspeed trip, but for a range of speeds below normal maximum speed is controlled by constant-pressure governor. If speed-reducing gear is interposed between turbine and pump, turbine runs at 3,500 r.p.m. Reduced in ratio 3.04 to 1, pump, at 1,150 r.p.m., has capacity of 90 g.p.m., on heavy fuel oil of 1,000 SSU. viscosity against 300 lb. pressure. Can be used for pressures as high as 500 lb. Pump of directly-connected unit illustrated is single-end, single-suction type, with all thrust in hydraulic balance, while the turbine-driven geared unit is of balanced opposed-rotor type.

De Laval Steam Turbine Co., Trenton, N. J.

Regulator for Combustion Control

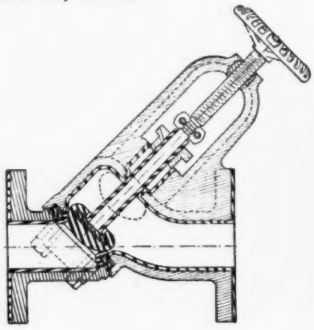
Designed for smaller and medium-sized boiler plants. Employs 4½-in. cylinder and operating arm with 12-in. travel at outer end, thus covering all need for controlling dampers, gas and oil firing valves, air inlet louvers, forced draft fans, stoker steam valves, and rheostat. Pilot valve on top causes sensitive positive control within close limits and compensating feature prevents hunting. Operation as follows: Pilot valve spring is set to balance required boiler pressure imposed on pilot diaphragm. As pressure rises above set point, steam or water is admitted through pilot valve into regulator cylinder. Piston moves and closes down damper and firing valves to point required by boiler load. If steam pressure falls below set point, reversed action occurs. Regulator suitable for controlling boilers under steam pressures from 3 to 450 lb. per sq.in.

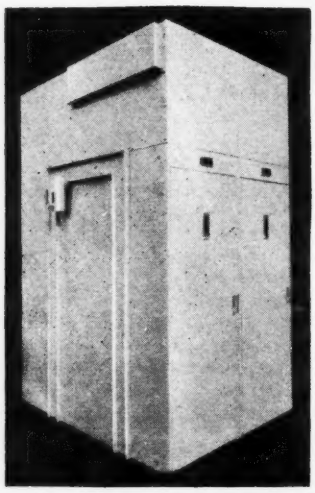
Morey & Jones, Ltd., 922 S. Hemlock St., Los Angeles, Calif.

Rubber-Lined Valve

Vulcalock valves are designed for handling corrosive and abrasive fluids under fairly high pressure, pulsating pressure, throttling or suction. Valve is lined with any of standard Goodrich Acidseal rubber compounds, hard or soft, and does not depend upon flexible diaphragm. Resilient rounded disk which snaps over a circular plate at lower end of stem provides seal when brought into contact with the molded rubber-covered seat. Both disk and ring easily replaceable. Steady uniform flow, with positive shutoff, obtained. Valve lining bonded to metal parts by patented process. Almost straight line of flow. On sizes up to and including 6 in., no restriction of flow through seat ring. Can be changed quickly from straightway to angle valve. Cast iron body of new, two-piece Y construction, designed to withstand working pressures up to 150 lb. per sq.in. No torsional stress on stem either in opening or closing valve. No rotary motion of stem through stuffing box. Stuffing box cast integral with main or upper body section.

B. F. Goodrich Rubber Co., Akron, Ohio.





Metal-Clad Switchgear

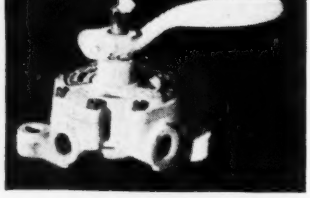
Compact, totally enclosed switchgear, assembled at factory. Easily installed at minimum expense. Voltages up to 7.5 kv. Oil circuit breaker, relays, plug type disconnect switches, insulated busses, wiring, cable terminals, etc., are mounted on a steel frame which fits in the steel enclosure. As load requirements increase, additional units can be added in any desired combination of generator and feeder sections. Each unit 10 ft. high, 2¾ ft. wide and 7 ft. deep.

Delta-Star Electric Co., 2400 Fulton St., Chicago, Ill.

Quick-Opening Disk Valve

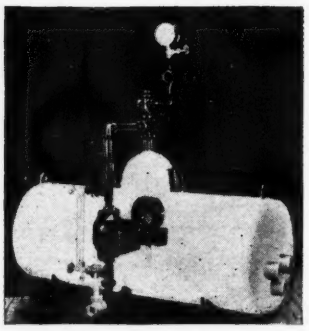
In Hanna "Unitite" valve, packless unit with simple arrangement for lubrication of moving parts, both disk and stem are quickly and positively lubricated by oil well in stem. Balanced disk pressure throughout contact area attained by arrangement of seat ports and disk pockets. Valve disk and bonnet may be reground without removing valve body from pipe line or disturbing pipe connections or valve mountings. Two-piece disk and stem rotate as unit. Disk free to find its own seat, and cannot be unseated by lateral force on stem. Universal type; may be used as straightway, three-way or four-way valves. Two inlet ports provided for ease of piping. Valves suitable for air, oil or water up to 250 lb. per sq.in. Sizes ⅜ to 1¼ in. in either standard or column mount type.

Hanna Engineering Works, 1765 Elston Ave., Chicago, Ill.



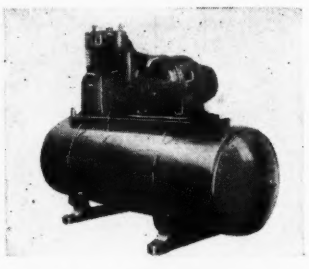
Electric Steam Generator

High- or low-pressure steam is supplied by this generator. Applications are restricted to uses where steam is wanted in limited quantities for process work, and in large plants where it has been found too costly to run steam lines. Ratings from



2 to 240 kw. Two pressure ratings, 100 and 200 lb. Quantity of steam may be flashed without reducing normal pressure with aid of an accumulator or flash capacity. Flash capacity is obtained by raising a large volume of steam to a higher pressure than normal requirements and providing a pressure reducer. Where steam demands are large for initial heating this arrangement is essential.

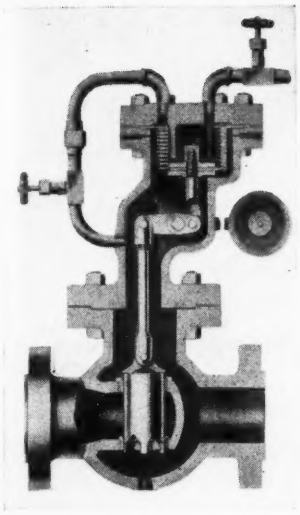
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.



Two-Stage High-Pressure Compressor

The Gardner-Denver 5x2x4 duplex two-stage high-pressure compressor is developed primarily for diesel engine starting, but may be used for other high-pressure air service including re-pressuring and oil well pumping. By changing size of high-pressure cylinder, and consequently cylinder ratio, machines are suitable for pressures of 150 to 1,000 lb. per sq.in. Bulletin AA-6.

Gardner-Denver Co., Quincy, Ill.



Differential-Pressure Control Valve

Copes Type SS-2 is improved design of the Type SS valve, has improvements in internal construction which permit valve to throttle higher pressure drops without chatter or unbalance. Internal parts also simplified and made more rugged. Unit made in ¾- to 6-in. sizes inclusive, in 250-, 400- and 600-lb. pressure standards. Range of control is 10 to 35 lb. per sq.in. differential pressure. Valve will handle pressure drops up to 150 lb., depending on size. Valve fittings, in either Monel metal or stainless steel, are designed for exact operating conditions specified by customer.

Northern Equipment Co., Erie, Pa.

Firebrick

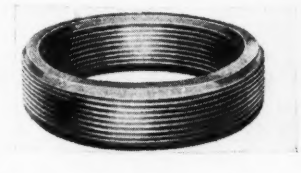
B. & W. 80 Junior was developed for moderate services between fireclay refractories and the B. & W. 80 firebrick. Melting point 3,175 deg. F., and pyrometic cone equivalent, 33. Claimed unusually resistant to spalling, and to have unusually high load-carrying capacity, as a result of special manufacturing process. Weight, 7¾ lb. for 9-in. straight brick.

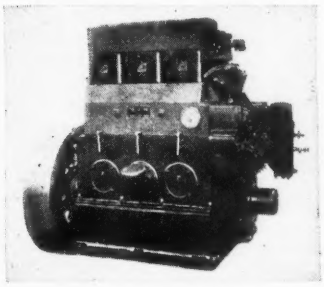
Babcock & Wilcox Co., 85 Liberty St., New York, N. Y.

Laminated Packing for High Steam Pressures

This laminated packing, for use in Yarway seatless blow-off valves, consists of several stainless steel rings with long-fibre asbestos packing between them. At time of assembly, it is compressed and heat-treated, so that finished ring is suitable for high pressures and temperatures. Slight clearances maintained between metal laminations and valve plunger. When subjected to blowdown tests at various pressures from 450 to 2,100 lb. with valves throttled to give severe operating conditions, it practically eliminated blowdown leakage. It has indicated life six times as great as packings previously used.

Yarnall-Waring Co., Chestnut Hill, Philadelphia, Pa.





Natural-Gas Engine

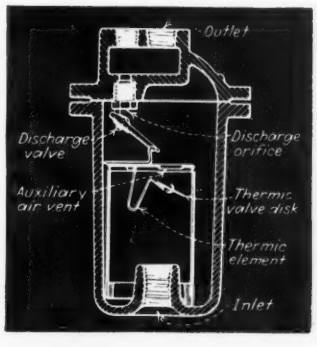
M. A. N., high-speed, natural-gas engines in sizes from 30-100 hp. at 1,000 r.p.m. Of 4-cycle, single-acting type, can be started by electric starter. Starting dynamo can be attached. Heat consumption, between ¾ and full load at 1,000 r.p.m., 10,000 B.t.u. per b.hp. hr. Fuel consumption at half load about 12,800 B.t.u. per b.hp.hr., so that 60 kw.-hr. at full load and 55 kw.-hr. at half load per 1,000 cu.ft. of natural gas can be generated. Illustrated is 60-hp., 3-cyl., unit. Made by M. A. N. Co. (Maschinenfabrik Augsburg-Nurnberg A. G.) Sold in United States through:

F. J. Joerger, 40 Rector St., New York City.

Trap With Thermostatically Controlled Bucket Vent

An automatic air bypass to promote quick heating, integral with Armstrong inverted bucket steam trap, has been developed. This special trap bucket has large auxiliary air vents. Closed by flat disk of stainless steel on end of strip of rustless thermostatic bi-metal double-riveted to bucket cap. As long as trap is cold, disk is held away from vent and air escapes so rapidly that bucket cannot float and close discharge valve. Air blows through until steam fills radiation and reaches trap, causing thermic strip to seat disk, which prevents steam from escaping through auxiliary vent. Thereafter, trap functions in normal manner.

Armstrong Machine Works, Three Rivers, Mich.



Hot-Rolled Seamless Boiler Tubes

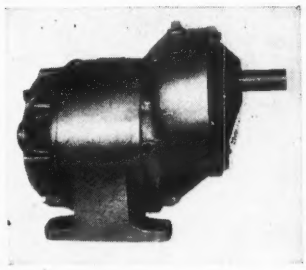
Complete line of hot-rolled, seamless-steel boiler tubes. Push-bench mill, only one of its kind in this country, is used for manufacture, giving exceptional ductility and causing tubes to lend themselves to rolling in and beading. Surfaces both inside and outside smooth, to retard corrosion when tubes are in use and to minimize depreciation while held in stock. Product complies with A. S. M. E. Boiler Code, A. S. T. M. Specifications, and U. S. Steamboat Inspection Service Rules & Regulations.

Jones & Laughlin Steel Corp., Pittsburgh, Pa.

Fresh Air Intake (Right)

These louvres or fresh air intakes are made from heavy gage galvanized sheets for any wall opening, or of other materials where preferred. All units are adjustable, smaller by hand, larger by geared power. Bronze pivots on blade ends operating in bronze bearings. Dust-protected ball-bearing operating blades are furnished for thermostatic controls. Also manufacture automatic back-draft louvre with aluminum blades.

Burt Mfg. Co., Akron, Ohio.



Gear-Head Motor

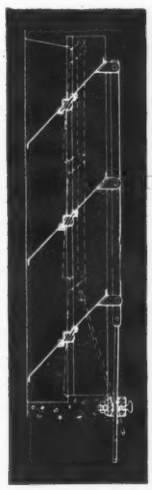
Type S gearmotors are scarcely longer over-all than motors and make substantial economies possible because of neat appearance and compactness. Drives from ½ to 75 hp. and for 1,550 to 232 r.p.m. May be connected direct to driven equipment or by cog-belts, chains or flat belts. Fourteen reductions from 1-12 to 1-5.1 available for each motor speed and horsepower. Changes in output speeds can be made readily at a small percentage of initial cost. Helical gears, fully enclosed, running in continuous oil bath, insure quiet operation.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Small Circuit Breakers

Breakers, rated up to 600 volts and 600 amp., and designed for control and protection of industrial circuits, employ unusual principle of arc interruption, operate quietly and permit no external arc. Arc occurs within closed metal chamber to interrupt circuit in 0.008 sec. Breakers are trip-free from operating handle and cannot be held closed when overload exists on circuit. On and off positions clearly marked, and yellow target appears when breaker opens on overload. Overload tripping initiated through bi-metallic thermal strip with time lag inversely proportional to magnitude of overload. Textolite housing, and provision made for convenient mounting of breaker. Known as Type AF-1.

General Electric Co., Schenectady, N. Y.



Burt Air Intake left, G.E. Breaker above, Feeder Regulator below

Feeder Regulator

This new type automatic feeder voltage regulator is for application where induction type of regulator has previously been used. Can also be used on higher operating voltages than those for which induction regulator can be economically designed. Equipment operates on basis of an automatic tap-changing device, with suitable transformers, all built into small unit. Claimed to give more economical and more efficient regulation of small-capacity feeders. Can be installed either indoor or outdoor for single- or three-phase operation.

Allis-Chalmers Mfg. Co., Milwaukee, Wis.

POWER LINES

American Radiator Acquires Ross; Announces Air-Conditioning Units

American Radiator & Standard Sanitary Corp. has announced development of a complete line of air-conditioning equipment for industrial and residential installation. The air-conditioning plants are described as being fully automatic in operation and from a central location will cool in summer, heat in winter, add or reduce the amount of moisture in the air, purify and circulate the air during all seasons of the year.

Refrigeration is provided by a "Decalorator," which uses only steam and city water. In a unit for use in conditioning offices, hotels and hospital rooms, the principle of the gun silencer has been used to eliminate noise.

Subsidiary companies that have contributed to this line of air conditioning equipment are American Radiator Co., Campbell Metal Window Corp. of New York; Fox Furnace Co., Elyria, Ohio; American Blower Corp., Detroit, Mich.; and Ross Heater & Mfg. Co., Inc., Buffalo.

Ross Heater & Mfg. Co. Inc., was recently acquired by American Radiator Corp. Services of the two companies to the petroleum industries will hereafter be carried on by Ross as a division of American Radiator. All inquiries relating to products of the Ross Heater & Mfg. Co. and the Industrial Division of American Radiator Co., should be addressed to the nearest Ross Heater & Mfg. Co., Inc., office or the main office in Buffalo.

N.E.M.A. Backs Government on Industrial Control Bill

The electrical industry of the United States, as represented by the National Electrical Manufacturers Association, has taken no stand on the industrial control bill or on any of its provisions, Arthur W. Berresford, managing director of the Association, has declared. The policy of the Association, Mr. Berresford explained, is to cooperate unreservedly with the Federal Government in carrying out legislation which may be enacted by Congress.

"There is, however," Mr. Berresford asserted, "no commitment to any definite program for the proposed control of industry. What the law specifically requires or permits the Association will do and with full appreciation of the major objective—the return of men to work."

Bay State Kills Chances of Keeping Smoke Inspection

By a recent decision of the Supreme Judicial Court of Massachusetts, hopes of continuing the work of the smoke inspection division of the state Department of Public Utilities on the present basis were destroyed, and functions of the division will be recast on much more limited lines. Dr. H. A. Christian of Harvard Medical School and others sought to obtain a writ of mandamus against the secretary of state to compel him to take steps for a referendum on Ch. 76, Acts of 1933, which curtails the functions of the division as described in *Power*, May, 1933, page 279. The court ruled that the state constitution forbids a referendum on a law of this kind, which is applicable to a limited district only. The petitions had asserted before the full bench that a state-wide interest was conceivable in the problem of smoke abatement. The staff will probably be reduced from about 18 to 5 persons and headquarters transferred to the new Department of Public Works Bldg., 100 Nashua St., Boston. No scrutiny of plans for boiler plants from the smoke abatement standpoint will be the duty of the inspection force under the new law.

H. H. MOSS

Recently awarded Miller Medal of A.W.S. for his achievement in the application of fusion welding and oxy-acetylene flame cutting

Welding Neck Flange Standard Submitted for Criticism

A proposed American Standard for Steel Welding Neck Flanges has been developed by a Subgroup of A.S.M.E. Subcommittee No. 3 on Steel Flanges and Flanged Fittings and is now being distributed to industry for criticism and comment. This proposal covers steel pipe flanges designed for welding to the pipe and thus will provide an alternative to the screw and lapped connections covered by the American Standard for Steel Flanged Fittings and Companion Flanges (B16e-1932). The steam service pressure ratings of these welding neck flanges are identical with those for the Steel Flanged Fitting Standard. The six series included in the proposed standard are: 150 lb. per sq. in. at 500 deg. F. (100 lb. at 750 F.); 300 lb. at 750 F; 400 lb. at 750 F; 600 lb. at 750 F; 900 lb. at 750 F; 1,500 lb. at 750 F. The range of sizes included in each series is considered sufficient to cover the present needs of industry and the mating dimensions in each case are the same as those of the corresponding screwed or lapped flange, so that complete interchangeability is assured.

Winton to Build Engines For 110-M.P.H. Train

A railroad answer to the airplane for speed in transportation is to be furnished by the Union Pacific Railroad, which has just announced a new high-speed train to be in operation before the end of the year on the Chicago-Los Angeles run. Powered by a 900-hp. Winton diesel-electric or oil-electric drive, it will make 110 m.p.h., 20 miles faster than the hitherto world's fastest, the Hamburg flyer running from Hamburg to Berlin, which makes 90 m.p.h. The new train will be of aluminum and steel, streamlined, air-conditioned, in a 3-car, 4-truck articulated unit weighing less than a standard Pullman car. It will carry 120 passengers.

Worthington and Gamon Consolidate Meter Interests

Worthington Pump & Machinery Corp. and Gamon Meter Co. have consolidated their operations in the manufacture and sale of meters, through the newly organized Worthington-Gamon Meter Co. Sales headquarters have been established at Harrison, N. J. All manufacturing operations, however, will be concentrated in the Gamon plant nearby, in Newark, N. J. Officials are: E. T. Fishwick, president; G. H. Gleeson, vice-president in charge of sales; J. A. Bonnet, secretary; R. R. Anderson, works manager.

Worthington Pump & Machinery Corp., Harrison, N. J., following completion of its new office building adjacent to the Harrison Works, has moved its general and executive offices to the new location. The New York sales office has been continued at 2 Park Ave.

News Notes

One sign of the times is the announcement just made that the Fourteenth Exposition of Chemical Industries will include a section especially devoted to the brewing industries, their processes and equipment. The exposition occurs during the week of Dec. 4, 1933. As usual, three floors of Grand Central Palace have been reserved. Over 150 companies have contracted for space.

The prospectus of the German Chemical Plant Exhibition ACHEMA VII has just been issued. This Exhibition will be held in Cologne during the week of May 18 to 27, 1934. The annual general meeting of the German Chemical Society and other scientific and technical societies will be held in Cologne at the same time. Preparations which have been made from the point of view of technical organization in the in-

terests of all those taking part in this Exhibition are fully set forth in the prospectus. Those interested may obtain a copy on application to the "Dechema" Deutsche Gesellschaft für chemisches Apparatewesen E.V., Achema-Geschäftsstelle, Seelze bei Hannover, Germany.

Work has commenced on an additional unit to the gas plant of B. C. Electric Railway Co., Vancouver, B. C. The initial unit was completed late last year. The new unit will increase capacity by 50 per cent, stepping it up from 3,000,000 cu.ft. to 4,500,000 daily. Twelve new intermittent vertical chamber ovens will be added to the twenty-four installed with the initial unit, and one extra producer and waste-heat boiler, one rotary washer and scrubber, one steam-driven exhauster with 3,000,000 cu.ft. capacity, a tar extractor, and two vertical cast-iron condensers (capacity for cooling 3,000,000 cu.ft. daily). Extensions will also be made to the napthalene washer. The total cost of the new unit will approximate $300,000. H. H. Simmonds is architect for the work, and Moncrieff & Vistuanet are contractors.

Seattle, Wash., plans a survey of the Skagit hydro-electric project and other units of the municipal light and power system by Ford, Bacon & Davis. Action was taken at the suggestion of Chairman V. C. Webster, in response to a telegram from Superintendent of City Light J. D. Ross, who is in Washington, D. C., negotiating with federal officials for financial assistance in the development of the Skagit project.

City Light's finances were thoroughly audited by Haskins and Sells, accountants, recently, and the results were satisfactory to the R.F.C. to which the city has applied for a $1,500,000 loan. Ross believes however, that the financial survey should be supplemented by an engineering survey.

Platte Valley Reservoir Assn., Gothenburg, Neb., Harry L. Williams, head, is perfecting plans for organization of a new irrigation district in the vicinity of Sutherland, Neb. Includes construction of power dam and hydro-electric generating plant on North Platte River, with transmission and distributing systems. Canals will be built for connection with present irrigation district. Fund of $4,500,000 is being arranged for the project.

Fraser - Brace Engineering Co., Montreal, Que., is negotiating with the Saskatchewan Power Commission, Regina, Sask., for permission to construct and operate a hydro-electric power plant on the Saskatchewan River, about 2 miles from Fort a la Corne, where site has been selected. Station will have a capacity of about 100,000 hp., and will be used for furnishing power in different parts of the province. Project will include construction of transmission lines, power and switching substations, and distributing systems. It is planned to take over a present steam-operated electric power plant at Saskatoon, and operate for stand-by service; this station is now a unit of the Power Commission's system. The entire program is reported to cost close to $10,000,000.

PERSONALS

L. W. Robert, Jr., due to his selection by President Roosevelt as Assistant Secretary of the Treasury of the United States, in charge of the Public Works program of the Federal Government, the Bureau of Public Health and chairman of the Federal Purchasing Board, has given up his engineering practice in Atlanta, Ga. Cherry Emerson, formerly vice-president and chief engineer, becomes president of Robert & Co., and Jesse M. Shelton becomes vice-president and treasurer.

Howard A. Stanley has been appointed plant engineer of Berkshire Fine Spinning Associates, Fall River, Mass. He will have charge of engineering activities in the various mills of this group, including those in western Massachusetts and Rhode Island as well as Fall River. Mr. Stanley was formerly vice-president and general manager of Fall River Electric Light Co., and more recently has been engaged in special electrical engineering service in Narragansett Electric Co., Providence, R. I., and New England Power Engineering & Service Corp., Boston.

L. H. States, formerly connected with the Philadelphia office of Allis-Chalmers Mfg. Co., Milwaukee, Wis., has transferred to Syracuse, N. Y., to handle products of the company in the central part of that state.

COMING MEETINGS

Sixth Midwest Engineering & Power Exposition—Stevens Hotel, Chicago, Ill., during "Engineering Week," June 27-29, of the Century of Progress Exposition. Headquarters, 308 W. Washington St., Chicago, Ill. 19 engineering societies meeting at same time. Program on page 289.

Nat'l Ass'n Power Engineers — National Convention, in conjunction with Niagara Frontier Power Conference & Mechanical Exposition, Buffalo, N. Y., Auditorium, Aug. 28-Sept. 2. Fred W. Rayen, Secretary, 1140 Lake St., Oak Park, Ill.

A.S.M.E. Oil & Gas Power Div.—6th National conference, Ritz-Carlton Hotel, Atlantic City, N. J., Aug. 23-26. Louis R. Ford, chairman, 29 West 39th St., New York City.

Canadian Electrical Ass'n — 43rd Annual Convention, June 14-16, Log Chateau, Lucerne-in-Quebec, Canada.

Second American Exposition of Brewing Machinery, Materials & Products—Auditorium Hotel, Chicago, Ill., Sept. 23-Oct. 1, together with meeting of Master Brewers Ass'n of America. James R. Nicholson, 55 West 42d St., New York, N. Y., secretary. Felix Mendelsohn, managing director of exhibit.

American Boiler Mfrs. Ass'n—45th annual convention, Skytop Lodge, Skytop, Pa., June 5-7. A. C. Baker, secretary, 709 Rockefeller Bldg., Cleveland, Ohio.

Amer. Soc. Htg. & Vtltg. Engrs. — Semi-annual meeting, Hotel Statler, Detroit, Mich., June 22-24. Secretary, 51 Madison Ave., New York, N. Y.

Joint Conference on Coordination and Control of All Prime Movers — At Woodward Governor Co., Rockford, Ill., June 20-23. An outgrowth of annual conferences on water-power control, of which this is sixth. Details: Irl C. Martin, above address.

Conn. State Ass'n Power Engineers—38th annual convention and exhibition, Hotel Green, Danbury, Conn., June 9-10. Geo. F. Klopfer, secretary, 70 Girard Ave., New Haven, Conn.

World Power Conference—Stockholm, Sweden, June 26-July 9. Program on page 290.

American Welding Society—Annual Fall Meeting, Book-Cadillac Hotel, Detroit, Mich, Oct. 2-6. Details, A. W. S., 29 West 39th St., New York City.

Ass'n Iron & Steel Elec. Engrs.—Mechanical, Combustion, Lubrication, Electrical and Safety Divisions, 29th Convention & Iron & Steel Exposition, Wm. Penn Hotel, Pittsburgh, Pa., Oct. 17-19.

Canadian Electrical Ass'n—43rd Annual Convention, Log Chateau, Lucerne-in-Quebec, June 14-16. Offices, Room 409, Power Bldg., Montreal, Que.

Leipzig Technical Fair Shows Diesel Progress

Impressions of visitors at the Annual Spring Fair at Leipzig, Germany, indicate that recent developments show a marked tendency towards simplification in design and controls, the use of welded structures for lightness, and the employment of airless injection with a wide variety of cylinder head designs. The Michel engine (*Power*, Feb., 1933) attracted unusual attention. M. A. N. showed a new all-welded heavy oil engine for bus and heavy motor transport work. It is a 6-cyl., 1,400-r.p.m. unit with an output of 100 to 110 hp. Deutsche Werke, of Kiel, showed a new welded steel 6-cyl. engine with a designed output of 220 hp. and running at 1,000 r.p.m.

BUSINESS NOTES

Earle Gear & Machine Co., Philadelphia, Pa., has moved its New York sales office from 95 Liberty St. to the Singer Bldg., 149 Broadway.

A 45% increase in sales since May 1, with a greater increase in inquiries, both foreign and domestic, is indicated by the current report of Foster Engineering Co., Newark, N. J. Practically all lines of the company's steam specialties have shared, indicating that the rise in volume of business is not confined to any one condition but rather to general improvement.

Industrial Engineers, Inc., 819-A East 59th St., Los Angeles, Calif., has been formed to render engineering, consulting and development services to the chemical process industry. F. L. Kallam, formerly chief engineer of the gasoline department of Foster Wheeler Corp., heads the organization, which has already produced a new air filter for large stationary gas engines and a vapor-pressure recorder-controller.

The Federal Power Commission has been upheld, in its action of two years ago, in taking jurisdiction of the New River power case by offering a major license to the Appalachian Electric Power Co. for its proposed power plant on that river. The decision is regarded as of far-reaching importance in connection with interpretations of the present powers of the Federal Power Commission and in connection with the proposals for the Federal Government advanced by President Roosevelt and others, for more extensive regulation and supervision of public utilities by the Government.

W. H. NICHOLSON & Co., Wilkes-Barre, Pa., has recently added these representatives: Howard See, Ass'n of Commerce Bldg., Grand Rapids, Mich.; W. B. Meyers, 4766 Clinton St., Los Angeles, Calif.; W. A. Wood, 1263 Division St., Evansville, Ind.; Harry Brod, Lewis Bldg., Portland, Ore.; S. Howard Eisenb g, 1530 Bellaire St., Denver, Colo.; and J. G. Iler, 520 Grandin Ave., Charlotte, N. C. J. B. Armstrong, who has been covering the northeastern section of Pennsylvania, will now cover the southeastern section and the City of Philadelphia as well.

ST. JOHN X-RAY SERVICE CORP., 505 Fifth Ave., New York City, has announced development of a new X-ray paper to replace celluloid film for industrial X-ray work. The new material is claimed to cost less than half the price of film, to be easier to handle, faster drying, to require only one intensifying screen instead of a pair, yet to be just as fast as the film and to give just as much contrast. Two sheets are exposed simultaneously in one cassette, one to be submitted with the job and the other for file. Developing time is only 3 min. at 68 deg. F.

GILL & GREEN, consulting hydraulic engineers of 17 Victoria St., Westminster, London, S.W. 1, have dissolved. E. N. Green has retired. J. H. W. Gill is carrying on the business alone.

MUNDET CORK CORP. has appointed C. R. Howard as distributor at Charlotte, N. C., to cover North and South Carolina. His office is at 408 Hillcrest Ave., Charlotte.

"REFRIGERATING WORLD" has changed its address from 25 West Broadway to 330 West 42nd St., New York City.

E. H. MERRICK, 3020 Coleridge Road, Cleveland Heights, Ohio, has been appointed exclusive sales representative in the northern Ohio territory for H. O. Swoboda, Inc., 3530 Forbes St., Pittsburgh, Pa.

PLIBRICO JOINTLESS FIREBRICK CO., Chicago, Ill., has established a manufacturing plant at Lake Shore Road & Eighth St., New Toronto, Ont., to be operated by a new Canadian company known as Plibrico Jointless Firebrick, Ltd. E. Morley Wilson of Toronto will be managing director.

MCALEAR MFG. CO., 1901-09 So. Western Ave., Chicago, Ill., have made some changes and additions in their representation. The new list is: Syracuse General Sales Co., Yates Hotel Bldg., Syracuse, N. Y.; Hery & Burns, 246 Cutler Bldg., Rochester, N. Y.; Geo. W. Skavish, 3235 38th St., N.W., Washington, D. C.; W. A. McLean, 337 S. High St., Columbus, Ohio; J. C. Ross & Co., 2719 First Ave., So., Seattle, Wash.; Geo. L. Cavaness, P.O. Box 292, Appleton, Wis.; Stanley Sales Co., 1440 Broadway, New York, N. Y.; Joseph F. Leonard, 3414 Noble Ave., Richmond, Va.; John B. Rogers, 2900 Central Ave., Birmingham, Ala.; Ritts Co., 609 Linwood Blvd., Kansas City, Mo.; Harry S. Bastian, 609 Railway Exchange Bldg., Portland, Ore., and W. C. Armistead, 207 Ninth Ave., No., Nashville, Tenn.

The Purchasing Department of the Caldwell-Moore plant of Link-Belt Co., Chicago, has been moved to the company's Pershing Road plant at 300 W. Pershing Road, Chicago, thus combining all purchasing for the two plants under supervision of Henry M. Coen, purchasing agent.

BRISTOL CO., Waterbury, Conn., has moved its New York office to the Daily News Bldg., 220 East 42nd St. C. W. Williamson, district manager, continues in charge.

ASSOCIATE ENGINEERS, INC., 1233 East 144th St., E. Cleveland, Ohio, has been organized and incorporated under the laws of the State to do consulting and contracting business, to prepare plans and specifications for machinery, buildings, and foundations, and to undertake the performance of contracts for the construction and erection of said apparatus, to design, manufacture, buy, sell, erect and install heating, ventilating and refrigerating systems, gas, byproduct, electric, boiler and water softening plants, and similar power materials. J. H. Gleason is president, and Geo. P. Webster, secretary.

VULCAN SOOT BLOWER CORP., a Pennsylvania Corporation, of Du Bois, Pa., manufacturers of Vulcan soot blowers, has been organized as successors to The Vulcan Soot Cleaner Co. Officers of the new corporation are: J. R. Osborn, president; Fred J. Brown, vice-president; J. E. Du Bois, M. H. Hartzfeld and J. Q. Groves, directors; W. N. McCreight, secretary and treasurer; D. E. Hibner, Jr., chief engineer and Fred C. Arey, consulting engineer. The corporation succeeds to a pioneer business established in 1904.

CHARLES C. PHELPS, manufacturers' agent, has moved from 11 Park Place to 125 Church St., New York City. Mr. Phelps is Metropolitan District representative jointly for Ellison Draft Gage Co., Leavitt Machine Co. and Combustion Control Division of A. W. Cash Co.

REPUBLIC STEEL CORP. has moved its Buffalo sales office to 475 Abbott Rd., according to an announcement by N. J. Clarke, vice-president in charge of sales. Thos. B. Davies, district sales manager, continues in charge.

Gurney Elevator Co. Inc., has been awarded the contract to remodel five existing elevators in the Great Northern Hotel, 118 West 57th St., New York City, by the Coleman Holding Co., owners, and Randolph H. Almiroty, architect. This work includes new elevator machines, motors, controllers, signals and cabs. Work is to commence at once and be completed by Aug. 15.

PEABODY ENGINEERING CORP. has moved its main offices from 40 East 41st St. to 580 Fifth Ave., New York City. The company has also recently taken over a factory in Stamford, Conn., where all Peabody equipment ill be manufactured.

Torrington Mfg. Co., Torrington, Conn., which has manufactured propeller-type fans for 32 years, has purchased the good will, patents and tools of Arcoil Mfg. Co., Newark, N. J., makers of "Arcoil" patented squirrel-cage fans, and will manufacture and sell both types of fans.

PLIBRICO JOINTLESS FIREBRICK CO., Chicago, Ill., has appointed Geo. L. Simonds Co., Winter Haven, Fla., as distributor with warehouse stocks at Jacksonville and Tampa.

ASSOCIATION MANAGEMENT, INC., 230 Park Ave., New York City, has been formed to manage the trade association activities of business and industrial groups. By taking a number of non-competing groups as clients, the organization will spread the cost of a Washington headquarters and such services as statistical merchandising, cost accounting, etc.

MYERS ENGINEERING EQUIPMENT CO., Mart Bldg., 401 So. 12th St., St. Louis, Mo., has been formed for the engineering and sale of heated steam for ventilating, air conditioning and refrigerating equipment. A branch office has been opened at Eldorado, Ill., under John C. Porter.

AMERICAN MANGANESE STEEL CO., INC., Chicago Heights, Ill. and F. A. Fahrenwald have terminated their contract. Under the agreement now existing, AMSCO retains the right to use certain patents issued and pending, while the company has granted Mr. Fahrenwald the exclusive use of the registered trade-name "Fahralloy", effective July 1, 1933.

HENSZEY DE-CONCENTRATOR CO., Watertown, Wis., has appointed the following representatives: Fenno-Fischer Co., 1201 Chestnut St., Philadelphia, Pa.; Ambler & Riter, 810 14th St., Denver, Colo., Ambler & Riter, Kearns Bldg., Salt Lake City, Utah; Commonwealth Electric Co., 417 Broadway, St. Paul, Minn., and Precision Instrument & Sales Co., 2719 First Ave., South, Seattle, Wash.

SCULLY-JONES & CO., 1901 S. Rockwell St., Chicago, Ill., has acquired the American Specialty Co., Chicago, according to announcement by James A. Scully, president. This company has for many years manufactured a complete line of sleeves and sockets.

FRITZ HOVING has been appointed West Coast district sales manager of Babcock & Wilcox Tube Co. in order to give A. M. Castle & Co. assistance of a local direct mill representative. Mr. Hoving will make his headquarters with A. M. Castle at 2200-2300 E. 55th St., Los Angeles, Calif.

OBITUARIES

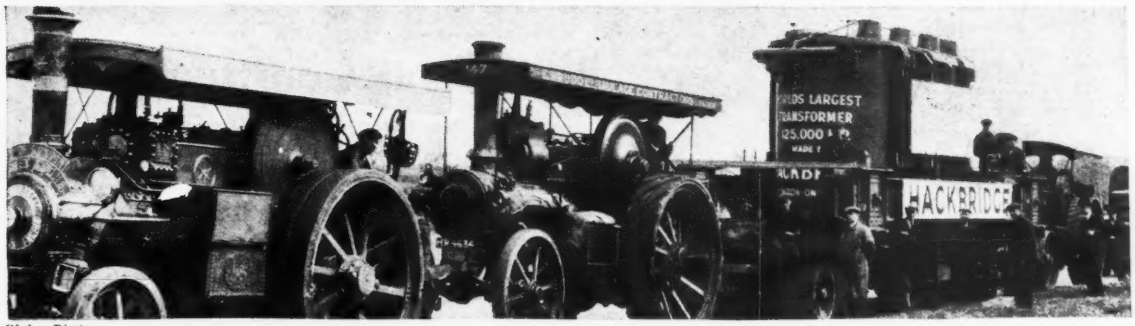
OTTO ALBRECHT, 94, inventor and for many years mechanical engineer for Bement-Niles Co., Philadelphia, and later with Tindel-Morris Co., Eddystone, Pa., died May 21 in Philadelphia.

WM. HENRY CREIGHTON, 73, emeritus professor of mechanical engineering, Tulane University, who retired last year, died recently at his home in New Orleans.

HARRY H. CUTLER, 73, electrical inventor and founder of Cutler-Hammer Co., Milwaukee, Wis., died in Miami May 20. He founded the company in Chicago in 1893 and was an official until 1917, when he sold his interest and retired.

CLARENCE EVERETT DOOLITTLE, 69, consulting hydro-electric engineer and fellow and member for life of the A.I.E.E., died at his home in Glendale, Calif., April 29. He was vice-president and general manager of Consumer's Electric Light & Power Co. until 1905 when he went to Chili to install the hydraulic works for the first mill built by Braden Copper Co., now part of the Kennecott holdings. Ill health forced his retirement from active practice in 1923.

FRANK RICHARDS, 94, former editor of *Compressed Air Magazine*, retired mechanical engineer and one-time superintendent of Ingersoll-Sargent Co., died at his home in North Plainfield, N. J., May 21.



Globe Photo

WORLD'S LARGEST TRANSFORMER—This 125,000-hp. transformer, weighing 120 tons, made at Hackbridge Works, Hersham, England, was transported by truck and barge to its site at Barking Power Station. On site, it will weigh 165 tons

STRAWS

Pointing the way the business wind blows

Allis-Chalmers Mfg. Co. has been awarded the contract for four 115,000-hp. hydraulic turbines for Boulder Dam, to cost about $1,100,000.

Among cities planning municipal plants are Winfield, Ia., (diesel, to cost $65,000, vote June 14) Girard, Pa. (diesel, around 500 hp.), Scottsbluff, Neb. (diesel); St. Hyacinthe, Que. (diesel or peat-burning steam plant in city waterworks building); Munising, Mich. (Alvord, Burdick & Howson, Chicago, making survey).

The City of Greenville, Tex., has purchased two Nordberg diesel engines for its municipal light plant, to replace steam-driven units. One diesel is a 4-cyl., 1,000-hp., solid-injection engine direct-connected to a 700-kw., 80 per cent P.F. generator. The other is a 6-cyl., 1,450-hp. engine of the same type, driving a 1,000-kw. generator. Generators are 3-phase, 60-cycle, 2,300-volt, with V-belt driven exciters. Nordberg is also furnishing complete auxiliary equipment. The new units will be installed in the existing power plant where one of the old steam engines is now being removed.

Director of Business Control, Olaf Olson, State House, Olympia, Wash., has authorized plans for a new steam-electric power plant at state prison, Walla Walla, Wash. It is proposed to ask bids for equipment at early date, having plant ready for service in the fall. Estimated cost over $85,000. George M. Rasque, Spokane Savings Bank Bldg., Spokane, Wash., is architect.

Culpeper, Va., has engaged Wiley & Wilson, American National Bank Bldg., Richmond, Va., consulting engineers, to make surveys and plans for proposed municipal electric light and power plant, and distributing system, for which bond issue of $120,000 was recently authorized.

Binghamton, N. Y., has authorized an engineering survey to ascertain the possibilities of establishing a municipal lighting plant. Louis T. Klauder, consulting engineer, Philadelphia, Pa., under whose direction the municipal plants at Jamestown, New York and Hagerstown, Md., have been developed, has been retained to make preliminary survey.

City of Paris, Ky., has contracted with Fairbanks, Morse & Co. for a diesel light plant. Revenue bonds to the extent of $156,000 have been sold to finance the plant. Fairbanks, Morse has also received the following orders: Moose Lake, Minn., municipal light and power, bonds for $73,-000; Canton, Mo., additional engine for municipal light plant; Woodsfield, Ohio, 350-hp. engine to cost $22,000, entire station $30,000, in service in October.

Erection of the new power plant to develop 350 hp. for the Big Slide Mining & Development Co. will be undertaken by the firm's own employees under direction of S. A. Perrot, company engineer, 1875 Robson St., Vancouver, B. C. The hydro-electric plant will cost approximately $20,000 and will be erected at the junction of Kelly Creek with the Fraser River.

Three concerns have submitted bids for a diesel engine electric power and distribution system at Winchester, Va., it was announced by the light committee of the common council. Those submitting bids were Northern Virginia Power Co. (subsidiary of Potomac Edison Co.), Trans-American Construction Co. and Fairbanks Morse & Co. The first company has applied electricity to the city and private consumers for many years. Its bid was said to be somewhat lower than the present contract.

Virginia Public Service Co. has lopped one-third of its rates to the University of Virginia, and the school has temporarily abandoned tentative plans to build a generating plant of its own. University authorities were not prepared to say what the amount of the reduction was other than that it was "substantial." However, another authoritative source set the aggregate reduction at nearly 40 per cent. The university's power and light bill runs around about $32,000 annually. The new rate, therefore, is expected to save the school between $13,000 and $15,000.

Business on the West Coast will begin to pick up soon when work starts on the 271 miles of transmission lines which will connect Los Angeles, and other Southern California cities, with Hoover Dam. Department of Water & Power of Los Angeles has obtained a loan of $22,800,000 from the R.F.C. Contracts for machinery, equipment and material with manufacturers in states other than California will total $20,000,-000. Of this, $14,000,000 will be awarded for construction of the transmission lines. The remaining $6,000,-000 will be awarded by the U. S. Reclamation Service for installations at the dam to connect the Los Angeles service.

Stevenson, Wash., will soon have plans prepared for a municipal electric light and power plant on the Wind River, where site has been selected. Arrangements are being made by W. G. Hufford, mayor, and associates for financing about $100,000 for project, including construction of transmission line.

Bids are being asked until June 20, by Construction Service, Veterans' Administration, Washington, D. C., for new boiler plant at institution at Marion, Ind., including boilers, pumps and complete plant equipment, outdoor distributing lines, etc.

Heber Public Utility District, Heber, Calif., plans early call for bids for municipal water project, including motor-driven centrifugal pump, gasoline engine-driven centrifugal pump, with complete accessories; 16,000-gal. elevated tank on tower 80 ft. high, and other mechanical equipment. Philip W. Knights, El Centro, Calif., is engineer.

Board of Public Works, Fort Wayne, Ind., is planning early purchase of a 15,000-kva. high-pressure steam turbine, with auxiliary equipment, for installation in municipal station. Hoad, Decker, Shoecraft & Drury, Ann Arbor, Mich., are consulting engineers.

Columbus, Ohio, is considering tentative plans for a municipal hydro-electric generating plant at Griggs dam. A transmission line will be built to power substation in the city. Project is estimated to cost about $130,000. Department of Public Service, Broad & Water Sts., W. P. Hallencamp, director.

New Bulletins

POWER-PLANT EQUIPMENT — Foster-Wheeler Corp., 165 Broadway, New York, N. Y., has issued a new general catalog in loose leaf form describing major equipment of the company, including steam generators, condensers, water walls, centrifugal pumps, steam jet air pumps, superheaters, economizers, air heaters, and similar equipment. Bulletin covering pulverizers, feeders and burners, heat exchangers and industrial and process heaters will be added shortly.

WELDED PRESSURE VESSELS—Henry Vogt Machine Co., Inc., 10th and Ormsby Sts., Louisville, Ky., has issued a bulletin describing Vogt fusion welding, which is a supplement to the company's W-1 Homoweld catalog, and a card designed for reference which summarizes the 1931 A.S.M.E. code requirements for unfired pressure vessels.

HEATING BOILER SIZES—"Selecting the Right Size Heating Boiler," by Sabin Crocker, engineer of Detroit Edison Co., is the latest Lefax data sheet addition. Other recent ones include a universal calendar, "Weights of Flat Rolled Steel," "Properties of Saturated Dichlorodifluoromethane," "Circumferences and Areas of Circles, Squares, Cubes, Square Roots, Cube Roots and Reciprocals," "Board Measure," "Heat-Treatment of Springs," and an Index to Lefax data sheets.

MANOMETERS—Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa., has issued Bulletin 1320 on Bacharach direct-reading manometers in five standard types and 20 stock sizes.

WATER PIPE — Republic Steel Corp., Youngstown, Ohio, has issued a folder on "The Ideal Pipe for Water Wells," describing the company's line of electrically welded pipe.

TWO-CYCLE DIESEL ENGINES—Nordberg Mfg. Co., Milwaukee, Wis., has issued a new pamphlet describing its medium-size two-cycle Diesel engines.

FURNACE GAS REGULATORS—Carrick Engineering Co., Michigan City, Ind., has issued two new catalogs, "High Buildings With Low Fuel Bill," and Catalog 100 on "Carrick Furnace-Draft Regulators."

SYNCHRONOUS MOTORS—Ideal Electric & Mfg. Co., Mansfield, Ohio, has issued Bulletin 540 on Ideal "Self-Syn" Motors of the self-exciting, self-synchronizing, self-contained type that do not require external excitation.

DIRECT-MOUNTED PUMPS—The La Bour Co., Inc., Elkhart, Ind., has issued Bulletin 37 on its line of direct-mounted pumps.

TEMPERATURE REGULATORS—Atlas Valve Co., 282-286 South St., Newark, N. J., has issued the Victor Temperature Regulator "Data" and Price Book, giving information on Victor self-contained vapor type regulators for liquids.

LOW-TEMPERATURE FUSE LINKS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has issued a four-page leaflet describing application characteristics, construction and operation of low-temperature universal fuse links for use on all designs of inclosed primary fuse cutouts.

HEAT INSULATION—Eagle Picher Lead Co., Insulation Division, Joplin, Mo., has issued a catalog on Eagle insulating materials under the title, "Eagle Effective Heat Insulation."

SPRAY-COOLING EQUIPMENT—The Marley Co., 1737 Walnut St., Kansas City, Mo., has issued Bulletin 37 on Marley spray-cooling equipment, including complete data and illustrations.

ROTARY PUMPS—Northern Pump Co., Minneapolis, Minn., has issued a bulletin on Series 5000 Rotary Radial Piston Type Rotary Pumps with capacities of 1 to 150 g.p.m. at 4,000 lb. pressure in infinitely variable delivery.

VIBRATING SCREENS — Link-Belt Co., Philadelphia, has issued illustrated catalog No. 1362, giving sizes and types of vibrating screens available, with dimensions, descriptive matter and installation views. Both unbalanced-pulley drive and heavy-duty positive drive type screens are covered.

STEAM TURBINES—General Electric Co., Schenectady, N. Y., has issued a bulletin on "Steam Turbines for Mechanical Drive."

TRANSMISSION BELT — "Highflex Transmission Belt" is the title of a new 8-page supplement to the B. F. Goodrich Rubber Co., Akron, Ohio, Mechanical Goods catalog.

New Plant Construction

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ark., Newport—City, c/o City Clerk, plans light and power plant building, generating equipment. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

Ga., Cornelia—Habershaw Realty Corp., c/o L. B. Magid, pres., Cornelia, plans being considered for construction of modern central pumping and filtering plant to supply water to Cornelia, Tallulah Falls, Mt. Airy, Baldwin and Alto. $200,000.

Ill., Carbondale—City preliminary surveys light and power plant, incl. generating equipment, distribution system. Russell & Axon, Roosevelt Bldg., St. Louis, Mo., engrs.

Ill., Chicago—Chicago Tunnel Co., 754 West Jackson Blvd., requested loan from Reconstruction Finance Corp., for $9,156,000 for steam plant to supply heat to Loop buildings, to substitute proposed abandonment of underground tubes 40 ft. below street level now used for hauling coal and removing ashes.

Ill., Eldorado — City preliminary surveys power and light plant, generating equipment, auxiliary equipment and distribution lines. Warren & Van Praag, Milliken Bldg., Decatur, engrs.

Ill., Harrisburg—City Council preliminary surveys power and light plant, incl. generating equipment, distribution lines. Russel & Axon, Roosevelt Bldg., St. Louis, Mo., engrs.

Ill., Murphysboro—City preliminary surveys light and power plant, incl. generating equipment, switchboard, and distribution system. W. A. Fuller Co., 2916 Shenandoah Ave., St. Louis, Mo., engrs.

Ill., West Frankfort—City plans power plant, generating equipment and distribution lines. $800,000 bonds voted. Schneider Eng. Co., Chicago, Ill., engrs.

Ind., Marion—June 20, by Vet. Bu., Arlington Bldg., Wash., D. C., boiler house at U. S. Veterans' Hospital.

Kan., Eureka—City, E. B. Magee, clk., preparing plans municipal light and power plant and distribution system. F. E. Devlin, W.-K.-H. Bldg., Wichita, engr.

Me., Winter Harbor—Bids June 15, by Dpt. Interior, Interior Bldg., Wash., D. C., 11-apartment apartment house, radio intercept building, compass station building, power plant building at Schoodic Point, Acadia Natl. Park, near here.

Md., Owings Mill—Rosewood State Training School, 10 East Mulberry St., Baltimore, plans by H. P. Hopkins, 10 East Mulberry St., Baltimore, power house addition $45,000.

Mass., Gloucester—City, R. B. Foster, chn. sewerage comn., bids in June, pumping station. $25,000 or more. Fay, Spofford & Thorndike, 44 School St., Boston, engrs.

Mich., Mt. Pleasant—City retained Ayres, Lewis, Norris & May, engrs., Ann Arbor, to prepare plans and estimates for municipal power and lighting plant, incl. distribution system and offices. $100,000.

Neb., Kearney—City, Mrs. M. E. Burke, clk., plans increasing waterworks plant, incl. power generating equipment, also establishment of pole line distribution system. To be financed from earnings.

N. D., Bismarck—State Bd. Administration, E. G. Wanner, secy., plans power plant at State Penitentiary. $250,000 bond issue authorized. Pillsbury Eng. Co., 1200 2nd Ave. S., Minneapolis, Minn., engrs.

O., Ironton—Municipality plans electric light and power plant. To exceed $28,500.

O., Ottawa—City plans municipal light plant. H. P. Jones & Co., engrs., 2nd Natl. Bank Bldg., Toledo, making study for same.

O., Toledo—City Council considering construction municipal electric light plant. $2,000,000-$3,000,000. Project may be on work relief programme.

Okla., Cushing—City, J. W. Slint, mgr., plans constructing and equipment municipal light and power plant. $300,000 loan asked from Reconstruction Finance Corp. N. Barde, city engr.

Okla., Stringtown — Bd. P. Affairs, Capitol, Oklahoma City, new hospital and power house at Stringtown Prison, convict labor. $160,000. Layton, Hicks & Forsyth, Braniff Bldg., Oklahoma City, archts.

Tex., Waxahachie — M. Karrh, c/o W. P. Hancock, atty., Hancock Bldg., asked for franchise to construct electric light plant.

Va., Culpeper—City plans Diesel engine power plant. $120,000 bond issue approved. Wiley & Wilson, Lynchburg, engrs.

Wis., Beloit—City, P. Hamilton, mgr., plans by R. R. Brown, 1608 Harlem Blvd., Rockford, Ill., municipal light plant, incl. 280 hp. Diesel engines, each direct connected to 230 kva., 3 phase, 60 cycle, 2,300 volt generator with direct connected exciters and one 140 hp. Diesel engine direct connected to 111 kva., 3 phase, 60 cycle, 2,300 volt generator, with direct connected exciter with necessary auxiliaries, incl. switchboard and building.

Wis., Cedarburg—City, J. Schroeder, clk., making plans pumping station, well, reservoir, deep well turbine pump and booster pump. J. Donohue Co., Sheboygan, engrs.

Wis., Hartford—City, R. Abbot, clk., making plans waterworks, incl. pumping station, 100,000 gal. reservoir, deep well turbine pump, horizontal centrifugal pump, pumping station. J. Donohue Eng. Co., Sheboygan, engrs.

Wis., Mayville — Bids June 8, by City, C. Muench, clk., constructing sewage disposal plant and installing equipment, Cont. 1, 24x30 ft. and 17x36 ft. stone and tile buildings, piping and equipment. Cont. 3, furnishing thirty ¾ in. to 12 in. diam. valves, 386 fittings, 1,011 ft. ¾ to 8-in. wrought iron and cast iron (arco pipe) f.o.b. Mayville, Contr. 3, 4 non-clog sewage pumps and motors with central equipment, 1 clarifier mechanism, 4A flight conveyor type for tank 30x12 ft., alternate bid incl. 28x12x5 ft. tank, 4B circular distributor for 84 ft. diam. filter, 4-C, sludge heating equipment, 4-D sewage flow recorder, f.o.b. cars Mayville. W. G. Kirchoffer, Madison, engr.

Que., St. Hyacinthe — City soon takes bids complete municipal electric power plant. $100,000. T. D. Bouchard, mayor.

Equipment Wanted

PUMPING PLANT, etc. — **Heber, Calif.** — Heber Pub. Utility Dist. made plans pumping plant, two 3 in. centrifugal pumps, 300 g.p.m., with electric motors, 16,000 gal. corrugated iron or sheet metal tank, settling basin, etc. P. W. Knights, El Centro, engr.

SEWAGE PUMPING UNITS — **Los Angeles, Calif.**—Bids June 21, by Bd. P. Wks., rein.-con. sewage pumping plant, pumps, etc., to be built in vicinity of Terminal Way and Dock St., Terminal Island. J. J. Jessup, City Hall, engr.

TRANSMISSION LINE EQUIPMENT — **Los Angeles, Calif.**—Bureau Power & Light, H. C. Gardett, ch. engr. of design, 207 South Bway., has prepared list of electrical machinery and equipment to be purchased by Bureau, for construction of line, probable sizes and quantities are: 12 oil circuit breakers, 275 kv., 2,500,000 kva.; 38 oil circuit breakers, 132 kv.-2,500,000 kva.; 21 transformers 132/34.5 kv. 16,700/20,000/26,700 kva.; 7 transformers. 275/132 kv.-60,000 kva.; 4 synchronous condensers, 50,000 kva. in connection with Boulder Canyon Transmission Line.

PUMP, etc.—**Madera, Calif.**—Bids June 19, by J. Wakefield, city clk., pump with 140 brake hp. Diesel engine for city water pumping plant. Bidder to submit bid on both Diesel engine and 1,500 g.p.m. deep well belt driven turbine pump. Cost not to exceed $16,000.

GENERATING UNIT, etc.—**Fort Wayne, Ind.**—Bids June 10, by City, one 15,000 kw. steam turbine generating unit, accessories Div. 1; surface condenser with circulating pump, pump drives, air ejectors, and other auxiliary equipment, Div. 28, both erected on purchaser's foundations. Froelich & Emery, 410 2nd Natl. Bank Bldg., Toledo, O., engrs.

POWER BOILERS—**Hoffman Island, N. Y.**—Bids June 21, by Treas. Dpt. at office Sup. Archt., Wash., D. C., furnishing, installing 2 new power boilers and equipment.

POWER PLANT EQUIPMENT — **Bismarck, N. D.**—Bids June 12, by State Industrial Comn., J. Mulley, secy., furnishing, installing power plant equipment, incl. boilers, turbines, generators, at power plant at state penitentiary. $250,000. Bond issue authorized. Pillsbury Eng. Co., 1200 2nd Ave. S., Minneapolis, Minn., engrs.

TURBINE PUMPS—**Canton, O.**—Bd. Control bids about June 26, 6 deep well turbine pumps to replace remaining shallow well lift pumps now in use in northeast water field. $10,000. J. Shisler, City Hall, engr.

TRANSFORMERS—**Wellington, New Zealand**—Bids June 27, by Secretary P. Wks. and Tenders Comn., 4 potential transformers and 1 spare E.H.T. bushing for Mangahao Power Scheme.